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NORTH WESTERN WOODPECKERS.

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(*With a Coloured Plate.*)

In the order *Scansores* (Lat. *scandor*, to climb), the toes are arranged in pairs, two project forwards, and two backwards—there are exceptional cases where one of the posterior toes is wanting—this peculiar form of foot is called zygodactylous, (Grk. *zugos*, a yoke, *daktulon*, a toe), or in plain English yoke-footed.

The scansorial birds of North and North-Western America, are represented by four families—parrots, *Psittacidæ*; trogons, *Trigonidæ*; cuckoos, *Cuculidæ*; and woodpeckers, *Picidæ*. With three groups we have nothing to do but have only to deal with the genus, *Picus*. Generic ch.—Bill equal to the head, sometimes a trifle longer, lateral edges very prominent, commencing about the centre of the base of the bill; nostrils near the commisure, culmen very nearly straight or slightly convex towards the tip. Bill broader than high at the base. The outer posterior toe is the longest, and the tarsus is about equal to the inner anterior toe. The wings reach to the middle of the tail, fourth and fifth quills longest.

There are a great many subdivisions of the genus, as defined above, but of very little importance or interest to the reader.

Woodpeckers are by far the most conspicuous birds the wanderer meets with in North-Western America, and as they are to be found everywhere, from the line of perpetual snow to the rocky sea coast, it is not to be wondered at that the lone hunter and fur trader learn to esteem the "peckers," and to look upon them with greater interest than either hunter or trader ever bestows on other feathered tenants of the forest, except such as appeal directly to the senses, *via* the throat and stomach. The very red men reverence woodpeckers, and the

"medicine men" hold their scarlet plumes to be "a medicine," all powerful to guide the arrow in an undeviating course; hence every bow has the crimson crest of a woodpecker dangling from its end, and the arrows are generally plumed with its wing and tail feathers.

Transport yourself, courteous reader, to the banks of the mighty Columbia, a thousand miles from the sea coast; never mind by what means you arrive, only try to suppose we are together, our head-quarters for the time the Hudson Bay Company's trading post, Fort Colville. Our first ramble shall be along the winding trail, leading over the sandy waste, on which the so-called fort stands; on our right hand (we must pass close to them) are several Indian lodges: these comical affairs are made of rush mats and scraps of hide, supported on a frame-work of sticks, with a hole at the top to let the smoke out; dingy little urchins by the dozen, may always be seen outside, rolling and frollicking amidst a pack of prick-eared curs, ever ready to bite a stranger's legs, their playmates, or each other for that matter, on the slightest provocation; flabby squaws crouch at the entrance-hole, door is a misnomer, whilst a peep through the gaping seams, reveals several half-naked savages, idling drowsily round a few smouldering embers, placed in the centre of this most squalid habitation. I should as soon think of obtaining pearls from a garden-snail, as poetic ideas from anything appertaining to the "Noble Savage." On our left, and behind us, the treeless plain—once clearly the bottom of a large lake, for the water-line is still visible round the edges of the encircling hills, and the gravelly surface is bestrewen with boulders and water-worn pebbles—stretches away for a good two miles, to meet the wooded slopes of a ridge of hills, that ascend in terraces composed of ancient gravels, until growing obscure in the mist and haze of distance, they seem to mingle their summits with the clouds; a-head a narrow stream, twists like a silver cord from the base of the hills, to join the Columbia; this stream we cross on a fallen tree, a bridge of Nature's own contriving, worn bare by the feet of the red skins that traverse it by the hundred during the salmon harvest; now we scramble up a steep shingly rise and stand on a level plateau, where gigantic pitch-pine trees, many of them 250 feet high, and straight as flagstaffs, grow thickly. I scarcely know a more beautiful pine than this, the *Pinus ponderosa*, which to a great extent replaces the Douglas pine (*Abies Douglassii*) everywhere east of the Cascade Mountains. The bark, arranged in massive scales, not unlike that peculiar to the cork tree, has between each of the shields or scales, deep clefts and fissures, like miniature valleys between mountains of bark, hollows

affording most admirable lurking places and sheltered retreats for all sorts of insects. Far below us we gaze down on a landscape, matchless in its massive grandeur and sublime beauty; a scene wherein primeval forests, craggy rocks, and a surging cataract, 400 feet in width, grouped by the hand of the Creator, fairly stagger one by their very immensity. The "Kettle falls" are not so remarkable for altitude, as for the enormous volume of water, that sweeps in foaming current over the jagged masses of basaltic rocks, through which the river at this spot breaks its way; here too the lake water which once filled the hollow we have just crossed evidently made its escape, whether let out by subsidence of the rocky barrier, or upheaval of the land below and around it, is not very easy to determine; about a mile above the Kettle falls the Na-hoi-la-pit-ka river joins its waters with those of the Columbia, and when thus reinforced, the river rushes on with a fearful velocity to reach the falls; its width at this distance from the sea is 400 yards, and in summer, when flooded by the melting snows, it rises quite 40 feet above its autumn and winter level. Before this resistless current takes its final plunge over the rocks, the entire river is split, so to speak, by an island, bare, rocky, and devoid of vegetation, save a few gnarled and twisted pine trees, that struggle for an existence amidst the clefts in the rocks. This island adds very materially to the charm of the scene, standing in mid channel, it gives one the idea that it is floating, just as if a small mountain had fallen into the river, and was being rapidly carried over the falls, and the more steadfastly we gaze at it, the firmer grows the belief in its possessing motion; thus staring at the island and the eddying rapids that whirl past it, I have often grown dizzy, and for a moment imagined that the rocks I sat on, and the entire river bank with them, were fast moving towards the falls. Below this insular clump of rocks, the waters again join and dash over the falls, so great is the force of the stream, that the water looks like moving snow, and from its seething, bubbling, and boiling appearance the fur traders have named it the "Kettle falls." This spot is the grand depôt for fishing, during the salmon "run," which takes place in June and July; over five hundred Indians then assemble here, in order to trap this lovely fish, to them an absolute necessity; cut them off from the salmon-harvest and they must inevitably perish, during the bitter winter, starved alike by cold and hunger.

The country east of the Cascades, where we suppose ourselves to be, differs entirely from that of the west side, or coast slopes, and this, together with other minor causes, makes the fauna of the district that lies betwixt the east side of the

Cascades, and western slopes of the Rocky Mountains, much richer in number and variety of species, than is found to be the case on the colder and more densely wooded slopes of the coast ranges westward of the "water-shed." The forests on the west side are extremely dense, the characteristic pine trees being *A. Douglassii*, *Thuja gigantea*, and several others which do not attain to so great a size; but everywhere there is a tangled chaos of under-bush, through which it is impossible for any animal larger than a rabbit to make its way, hence it is, that comparatively few animals are found there, excepting in and about the swampy places, known as wet prairies, and only such birds as love the dark solitude of the pine forests. But here, in the Colville valley, which may be accepted as a fair type of the general character of the country, extending in a southerly course into Oregon and California; northwards towards Sitka, the frontier of Russian-America, the forests again become dense, the under-growth thick and tangled, and the hills, as a rule, are only divided by deep narrow valleys, often little else than rocky gorges.

In this delightful (Colville) valley, we have every requirement to make it a paradise for all the feathered migrants, and although only the ridge of the Cascade Mountains divides it from the Fraser River districts, still we shall find numerous species of birds here, that are never seen on the western side; indeed I may safely say, that I could nearly define the water-shed, by noticing certain birds and animals, which seem to meet at this imaginary frontier, but never cross it, as far as I know, or mingle with each other. I may instance, in illustration of what I mean, two species of squirrel—the red-bellied squirrel (*S. Douglassii*) and the Hudson's Bay squirrel (*S. Hudsonica*), that never intercross, over the ridge of the Cascades, although they meet at the summit, one being invariably found on the east slopes, whilst the other is equally as constant to the west. The sharp-tailed grouse is confined to the eastern side, so are several of the woodpeckers we are about to consider; so is the yellow-haired porcupine, the badger, Says squirrel, and many other mammals. I could add a host of similar instances, but these will suffice.

The Colville Valley is, roughly estimating it, about twenty miles in length, and of varying width; a small stream flows through it, and the rounded hills on either side are but very sparsely timbered; and betwixt them, in every direction, are small lakes, belted with birch, alder, and poplar trees. Instead of the impenetrable brush, the ground under the timber, is here thickly clothed with bunch-grass, so called from its habit of growing in tufts; and from amidst its green luxuriance wild flowers of gayest colour, and often sweetly perfumed, flourish plentifully.

Now, if I have succeeded in impressing on your mind, by thus taking you an imaginary ramble, the general features of the country, wherein our friends the woodpeckers reside during the sunny summer time, it will help very much towards making clearer, what I have now to say in reference to the few species of woodpeckers, which I have selected for description, as offering many points of interest in relation to their habits, periods of migration, nesting, and feeding, not generally known.

Thirteen species of woodpeckers may be found, during the summer season, in this valley and on the hills adjoining. The genus *Picus* has four representatives—Harris's woodpecker (*P. Harrisii*); the downy woodpecker (*P. pubescens*), called by the traders, settlers, and trappers, "sap-sucker," from an absurd idea they have, that the bird punctures the trees in order to make the sap run out, and then sucks it up; Gairdner's woodpecker (*P. Gairdneri*); and the subject of the illustration, the white-headed woodpecker (*P. albolarvatus*). The first three species frequent damp, swampy spots, their habits are very similar, and they are often seen together on the same tree. The colour of the plumage in all three is simple in the extreme, consisting of a plain suit of black and white, the white arranged in stripes on the back, and in spots on the outer surface of the folded wing. The larger of the three (*P. Harrisii*) measures only 9¼ inches; the smaller (*P. pubescens*), 6¼ inches.

When wandering through these dark swampy patches, wherein rank vegetation springs from death and decay, where fungoid growths flourish, and long pendants of lichen hang like whitened beards, from the moss-covered mouldy trees, we are certain to see either one or the other, if not all three, of these tiny woodpeckers. The busiest of the busy, they run along on the rotting sticks and logs, anon stopping to excavate a hole, in order to reach the snug gallery of some fat larva; then head downward peer into every crevice in which an insect would be likely to hide itself, or continually casting sidelong glances in every direction, look sharply for the approach of an enemy. Having exhausted this hunting ground, in jerking flight they seek another. Watch them from dawn to dark, and you never see these little woodpeckers resting, or ceasing their search for insects. Their digestive powers must be prodigious, or they can rarely get good sport, for it seems to me they never abandon their labour, as other birds do, when hunger is appeased. The trio make their nests (often choosing the same tree) in holes dug in for a short distance horizontally, then excavated vertically to a depth of two and three feet; no lining of any kind is provided for the eggs to rest on, except some of the finer dust, obtained whilst digging the hole. A dead cotton-wood, alder, or willow is usually the favoured tree,

and the holes are almost invariably made in the stem of the tree, never—or at any rate but very rarely—in the wood of the branches. They make their appearance from the south in May, and very soon after their arrival pair, and commence the cares and pleasures of parental duty.

The white-headed woodpecker, admirably portrayed in the coloured plate by Mr. Wood, who made the drawing from specimens of the birds in my own possession, is the rarest and least known of all the north-western species. Professor Baird, in his invaluable work on the birds of America, p. 97, says, speaking of this woodpecker, "it is an exceedingly rare species, not more than three or four skins being known to exist in collections." Mr. Cassin named it *Leuconerpes albolarvatus*, and was the first to describe it, from specimens obtained somewhere in California; but as it belongs to another genus, Professor Baird has retained as its generic name that of *Picus*.

Sp. ch. The colour is bluish-black, with the exception of the head, which is snowy white; the outer edges and entire basal portion of the primaries are also snowy white; the fourth and fifth quills are of equal length, and somewhat longer than the others; there is no trace of white on the first primary, excepting a spot on the concealed end of the basal portion; the white on the outer web of the other wing feathers terminates about three quarters of an inch from the tip, a large patch of white being visible in the folded wing; the beak is particularly strong, wedge-shaped at the point, and sharply keeled or ridged from its base to its tip; nostrils large, and partially hidden by tufts of hair-like feathers that spring from the base of the beak; feet and claws remarkably strong, the outer hind toe being double the length of the inner, and somewhat longer than the two anterior toes; tarsi strongly scaled; no white on the tail, and the shafts of the feathers are very stiff and strong; the male differs from the female only in having a narrow stripe of bright scarlet, partially encircling the nape, and dividing the white from the black of the back; the white is continued down the throat to the upper part of the breast, where it terminates abruptly. Length about 9 inches; wing, 5¼ inches; tail, 4 inches.

I first saw this most quaintly-coloured woodpecker, creeping round and round the trunk of a massive pitch-pine, growing on the plateau where we together indulged in an imaginary peep at the "Kettle falls." Never before had I seen any bird in this region so conspicuously coloured, or in such direct contrast to the red bark of the trees, amongst, and on which, it was hunting. The bird, too, had spied me out, and clearly deeming me an enemy, carefully kept the tree betwixt us. In vain I tried

every artifice I could think of to get a shot at this, to me, novel visitor; but do what I would, the crafty fellow managed to elude me, and although it was continually flying from tree to tree, never by any accident did it quit the one it was hunting on, but on the opposite side to that, on which I was watching.

Hour after hour I followed the bird, all the while, playing a continuous game of hide and seek; night was rapidly approaching, and I was nearly abandoning every hope of killing it, when an owl frightened the poor little "pecker" into utter forgetfulness of its previous caution; it unwisely flew past me, and I shot it. The sketch of the male, illustrating this account of the white-headed woodpecker, was made from the stuffed skin of the identical bird, which had cost me so much labour to obtain. A few days after this event, two or three more made their appearance, and day after day, their numbers steadily increased up to about the 12th of May. By this time the first arrivals had settled their love affairs, and the later comers were wooing. As soon as differences were adjusted, and connubial matters amicably arranged, the happy couples at once betook themselves to the denser forest, on the hill sides. Stragglers might occasionally be seen, perhaps disconsolate old bachelors, or disappointed spinsters, hunting by themselves. The general migration was clearly over, and nesting, the grand aim and purpose of the journey, had commenced. During the period of love-making, four or five of these woodpeckers, generally only one of them a lady, might often be seen together on a log; and it was most curious to watch the males drooping their wings, and bending down their heads, evidently for the purpose of exhibiting their scarlet collars to the best advantage, strutting up and down the logs, and then circling round the lady as ancient beaux danced minuets; each male during this performance kept up a continuous chattering, not the least like the note—a short, sharp chirp—both male and female always utter when flying from one tree to another. Sometimes the programme was varied by a brief battle; fighting is evidently not cultivated, or esteemed a "birdly art of self defence" in woodpecker society. A more bungling hustle and scratch system of warfare, than that displayed by these love-sick woodpeckers, would be hard to imagine. I suspect the fair one does not make a careless selection, but devotes many days to satisfy her mind. The favoured one chosen, the rejected cocks, like sensible birds, at once look out for another unmated damsel, and are quite content, if they cannot have what they like, to accept what they can get. Their habit, when in search of food, is to shell off the scaly bark of the pitch pine. I have never observed them

digging in dead trees, or making immense holes, as the custom is with most of the other species, but confining themselves entirely to the one species of pine, they split the rugged bark, and throw it down in chips. I have often seen a heap of such *debris* at the foot of a favourite tree, three feet and more in depth, and any one would at once say, unless he saw the birds at work, that some person had been busy with an axe chopping off the bark. The purpose of all this digging is at once evident, if with a stiff knife, you split some of the thick corklike junks of bark, that stud the trunks of all old pitch pines,—a peculiarity of structure very unlike anything one sees in other species—the interior of the split portion will be found to contain hosts of tiny beetles, or weevils (*curculionidæ*) I should more correctly say. These minute brown fellows live in small round holes which they bore in the bark, often so close to each other as to divide the thin wall separating their galleries. To reach the haunts of these bark-miners, the white-headed woodpeckers really, and not in mere figure of speech, chisel off the bark chip after chip, and when one is thus made fully conversant with the bird's habits, it becomes an easy matter to see how wonderfully the beak and claws are adapted to fulfil their necessary requirements. The beak is, to all intents and purposes, a horn chisel, or wedge, perhaps, is a better term, contrived most admirably as an instrument for splitting, if the most skilled mechanic were to try his best to fashion an efficient wedge, I unhesitatingly say, without fear of contradiction, that he could not, with all his art in handicraft, design so perfect an instrument as this little woodpecker is supplied with. To work the wedge with effect, when the bird is clinging to the trunk of a tree, as often with its head downwards as in a vertical position, needs a contrivance with which it can steady itself firmly, whilst forcing its beak through the bark, which is tough, and therefore does not easily give way. Now turn we to the feet, and we shall see at a glance how perfectly they are contrived to accomplish this purpose. The long sickle-shaped claws, resemble those of a bird of prey more than an insect feeder, and are veritable anchors, that fasten on the inequalities of the bark, and hold the bird as firmly as if it was nailed to the tree. The holding power of the claws is well shown, by shooting one of these birds, when it is in the act of splitting the bark. If killed, it will not fall to the ground, but remains clinging to the tree, kept there by the hooked claws, that even in death do not relinquish their grip. The outer hind toe, being so much lengthened, adds materially to the power of steadying the body. The tail is also a powerful auxiliary to the feet; its sharp pointed stiff feathers, when depressed, and tightly pushed against the roughened surface

of the tree, act as scaffold poles, and firmly resist all backward pressure.

The wedge-like beak, would be a very inefficient instrument to capture such diminutive creatures, as these birds principally feed on, if unaided, and the required assistance is provided. The construction of the tongue is strangely modified to meet the necessity. The top of this curious instrument, as in all woodpeckers, is of a horny substance, very sharp, and armed with four small barbs or hooks, the points of which are directed towards the throat; more than this, it is always covered with an adhesive secretion, specially supplied by two small glands; the tongue can be easily pushed out to a great length, the peculiar arrangement of the hyoideal bones specially fitting it to be extended and retracted. I do not agree with those writers who imagine woodpeckers impale, or rather spear insects and larvæ with this formidable-looking weapon. My own opinion is, that it is only used as a kind of probe, placed under or against any luckless insects, "the catch 'em alive O," stops their scampering and kicking, whilst the serrated points prevent them from slipping off during the process of being dragged in and bolted. I carefully examined the stomachs of one or two specimens of *P. albolarvatus*, and found them crammed with the small brown weevils, that bore into the pitch-pine bark, but no trace of any other insect was discoverable.

I had many long hunts before I succeeded in finding the nesting-place of these woodpeckers, and then any chance of obtaining their eggs was a physical impossibility.

The hole in which the hen-bird lays her eggs, is always bored in the dead branch of a pitch-pine, often 150 or 200 feet from the ground; small branches are invariably, and without doubt designedly, selected for the purpose. The dead limbs are extremely brittle, hence the weight of the lightest squirrel would most certainly snap them off. That wondrous instinct by which all the feathered races are directed how best to guard their fledglings—some by concealment, others by suspending their nests, indeed nearly every species has some system, specially designed to frustrate the enemy most to be dreaded—has taught the white-headed woodpeckers to protect themselves, their eggs, or their children against the depredations of that most inveterate poacher, the pine-marten (*Mustela Americana*). Night and day this bloodthirsty rascal is ever prowling over the trees, on the look-out for anything eatable—squirrels, birds, and eggs are alike acceptable, "all's fish" that comes within reach of the bandit's teeth and claws. To avoid the crafty marten, the woodpeckers select a branch that will not bear up the animal's weight, and the glutton may lick

his lips in anticipation of the sumptuous feast stowed away in the hole, so nearly within his reach, yet he dare not venture on the treacherous branch to steal it.

The other woodpeckers, that build or rather bore out their nests in the dead and decaying trees about the swamps, need not a like protection, because the marten is seldom—I believe, I may say never—seen but on dry-timbered land.

When the young birds are strong enough to leave the hole, they sit on the branch during the day, and are then continually fed by the parents; returning, however, to their safe retreat before it grows dark. Having acquired the use of their wings, they separate from each other, and it is a rare thing to see two together, either young or old birds, after the nesting-time has passed.

If we quit the shadowy forest to wander over the grassy prairie-land, alive with insects, and decked with flowers, we shall be certain to see the red-shafted flicker (*Colaptes Mexicanus*). Birds belonging to the genus *Colaptes* (Greek, *kolapto*, to excavate), are characterized by having a slighter and somewhat incurved but sharp-pointed bill, and by tarsi and feet less powerfully constructed than in *Picus*. I scarcely know a more beautifully-plumaged woodpecker, or a more abundant one, in North-Western America than is the red-shafted flicker. Its brown back is banded by narrow lines of black, that transversely stripe each feather. The primaries are jet black, but the shaft of each feather is of a most brilliant scarlet; the secondaries differ only from these, in being spotted with brown, on the lower half. The under surface of the wing is also bright scarlet, like the shafts of the feathers. The two upper tail feathers are entirely black, whereas in the under ones, half the feather-shaft is scarlet, and the other half black; the under surface of the tail is scarlet, similar to the wings. Head brown, neck and throat ashy grey, marked on either side by a patch of scarlet; the breast is spotted, like that of our English thrush, and divided from the grey of the throat by a gorget of black feathers; rump white, tail coverts spotted, and banded with black. In the four species previously described, we found the bill to be strong, straight, and wedge-shaped, and that it was used too, as an instrument, for splitting bark and gouging out holes. In the "flicker," the beak retains little of its wedge-shape, but is altered into a regular pickaxe, and such it absolutely is, and nothing else. This woodpecker has an amiable weakness for ants, but still more for their new-laid eggs. The flicker cares not a single jot about the ant's proverbial industry, neither does it in the slightest degree respect the carefully-constructed mansions, so artistically built with tiny sticks, although the combined labour of many hundred workers, have taken, it may

be, years to erect it. With its powerful pickaxe, the greedy bird sends the building materials right and left, and soon exposes the egg-hoard, and then feasts right royally, taking a fat ant now and then by way of a make-weight. Not that beetles come amiss, or any other insect which by chance comes in the flicker's way, when it is hungry, or on the hunt for food. They also use this pickaxe for digging out their nesting-holes. The place selected for the nursery, is generally in the dead trunk of a standing tree, where the wood is very soft, and easily excavated. Both male and female work at this laborious job, and seem to encourage each other when digging, by the utterance of a quaint sound, not unlike a hearty laugh, when tempered down, and mellowed by distance. I have taken, though not often, eleven eggs from the hole, occupied by a single pair of "flickers," but six is about the average number laid; the colour of the egg is pure white. Its flight is strong, straight, and swift, and effected with little of the undulating motion common to woodpeckers in general; but is maintained by numerous flappings of the wings, broken by short spells of sailing. They begin to arrive from southward in May, and leave again about the middle of September. I believe these birds do occasionally eat ripe berries, such as wild raspberries, "service-berries," and strawberries, but I am not disposed to think they are frugivorous, or have any great love for a vegetable dietary.

Frequenting the open ground, but always where the trees grow in clumps, often alighting on the ground, and in their general behaviour closely resembling the jays, numbers of bright showy birds make their presence known, by the incessant chattering they indulge in, walking, flying, or resting on the branches, it matters not, they are always making a terrible noise, and one is puzzled to know whether the sound is meant for laughing, crying, singing, scolding, or, if the birds ever indulge in such improprieties, "chaffing." The gay perpetrators of this incomprehensible bird-jargon, are Lewis's woodpeckers *Melanerpes torquatus* (Greek *melas*, black, and *erpo*, to creep). These belong to a sub-family, the *Melanerpinæ*, the distinguishing characteristics of which would prove of trifling interest to the reader. The feathers clothing the under surface of this bird, possess a marked peculiarity, and resemble bristles much more than feathers. The fibres of these feathers are much longer than is usual, and stiff like very thick hair.

Dr. Baird thus describes* this peculiarity of feather. Speaking of the plumules in the breast feathers, he says, "Those on the terminal third of each feather are of the usual charac-

* "Birds of America," p. 116.

ter at the base, or provided with fibrillæ, those of the opposite sides interlocking as in feathers generally. The terminal portion, however, of the stem of the fibre is much enlarged and expanded laterally to twice or more the diameter at the root, and converted into quite a stiff bristle, nearly smooth, or with very slight indications in places of the fibrillæ."

The colours of this hairy-looking bird are also somewhat strangely blended. The back is glossy bottle green, but the breast, lower part of the neck, and a collar that goes all round it, are of an indescribable grey colour, tinted with pink. A blood-red ring encircles the base of the bill, and the greater part of the head is dark crimson. Belly a lighter shade of the same colour, streaked with white. Wings and tail bottle green and shiny like the back. The female in plumage differs but very little from the male. Length, ten and three-quarter inches, wing six and a-half inches.

This very interesting bird appears to combine the habits of the "flicker" with those of the "white-headed woodpecker." In a great degree arboreal, and sometimes chiselling off the bark to hunt for insects, after the manner of the white-headed woodpeckers; still it may be as constantly observed on the ground, picking insects from off the grass and flowers, and rooting out the ant's nests, as does the "flicker." Its mode of flight is not the least like that of a woodpecker, but is swift and straight, and when alighting on a branch, for it seldom if ever pitches *against* a tree, the feet grasp it, and the wings close, like those of an ordinary percher; more than this, I have frequently discovered seeds and berries mixed with insect remains in their stomachs. All this goes to prove that in habit at any rate Lewis's woodpecker (so named in honour of one of the two explorers who first visited these remote regions of the far north-west, Captains Lewis and Clark), closely links the jays (*Cyanura*) with *Picus* and *Colaptes*.

They nest in a hole excavated in the stump of a tree, and here again they differ from most other woodpeckers; these birds make a very substantial nest of grass and feathers at the bottom of the capacious chamber, hollowed out for its reception, whereas the others simply deposit their eggs on the bare wood, or at best only on the dust, accruing from gouging out the hole.

Lewis's woodpecker lays about seven eggs. The colour of the egg is pure white when the shell is emptied of its contents, but quite pink when taken from the nest. The entrance hole is never larger than is sufficient to barely admit the bird, forming, as it were, a narrow tunnel, that leads to a large globular-shaped chamber. Nothing much larger than a mouse could manage to squeeze its body through the passage; hence

there is but trifling danger of robbery from predatory mammals. At least a small basketful of chips must result from digging out so large a chamber, but what becomes of them is somewhat mysterious. I would defy the keenest vision to detect even a single bit of dust under or near to the hollowed tree. The birds must carry the chips and *debris* away and hide it—still I cannot say that I have ever seen them so employed—instinct surely treading very closely on the heels of reason, methinks.

Thus far, we have visited the open timber, the detached clumps of trees, and the "dark dismal swamp," and find each locality has its appropriate woodpecker. Did time and space permit it, we could climb the craggy hill side to reach the frontier dividing life from icy desolation, where we should find the three-toed woodpecker (*P. arcticus*) busy in its favourite tree, the *Pinus contorta*, or diving into the very heart and depths of the forest to scramble through rock-walled ravines, and dark solitary glens, there, also, if we do not see, we shall be sure to hear the rap, rap, rap, rap, and noisy laugh of the log-cock (*Hylatomus pileatus*). Frightening out the terror-stricken insects from their snug retreats, with the noise of his formidable hammer, he gobbles them up, and then, so one would imagine, laughs loudly at the success of his *ruse*. This woodpecker, the largest of all the north-western species, makes a hammering that can be heard distinctly quite a half a mile away. It is the scarlet plume of the log-cock the Indians so highly prize as a "medicine" or charm.

Go where you will, woodpeckers are sure to be met with, and, as the harbingers of summer, their arrival is always looked forward to, and hailed with delight by the lonely hunter, be he white or red man, for he knows when the woodpeckers make their appearance, that the ice-king has unlocked the crystal doors of his prison, and given his sceptre to the god of summer.

CONNEMARA.

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AMONG the many interesting corners of the British Islands, which present themselves before the mental vision of the naturalist, when he is cogitating as to whither he shall betake himself for his next holiday, there is perhaps scarcely one that combines so many points of interest—botanical, zoological, geological, physical—as that western district of the county of Galway, called Connemara. And, if attractive to the naturalist, it is scarcely less so to the lover of the picturesque; its mountain scenery being wonderfully wild and impressive. I propose, then, in the following pages, to give some account of my own impressions and observations during two short excursions, devoted to the zoology and botany of this region.

The naturalist bent upon the discovery of *new* species, or *new* habitats, would probably do better to turn his attention to some less thoroughly explored portion of the western Irish coast; the frequent quotation of "Connemara" after descriptions of species in scientific works, shows that the district has long been a favourite and productive collecting ground, so that perhaps the chances of absolutely new species turning up there, though by no means slender, are not so great as in some other places. Much of our knowledge of the flora and fauna of Connemara is, indeed, due to the explorations of the late William M'Calla, an enthusiastic young naturalist, resident at Roundstone, who fell a victim to cholera in 1849. His researches were rewarded by the addition of many species to the botany and zoology of the British Islands, as well as by the discovery of not a few forms of life altogether new to science. But other portions of the western coast are almost entirely unknown to naturalists. Dr. Perceval Wright says, "any young ardent zoologist will still find plenty of work to do among the western phocidæ and fish, and almost a new field in the shell-less molluscs, annelids, and cælenterata, of Donegal, Sligo, Mayo, Clare and Kerry."*

Connemara is easily reached from Westport on the north, or from Galway on the south. The latter is the most direct route from Dublin, but the former is much more interesting, as to the scenery amongst which it lies; and if economy of time be not a matter of very great importance, it is worth while to make the circuit by Castlebar, for the sake of the car-drive

* Quarterly Journal of Microscopical Science, July, 1865, p. 213.

between Westport and Clifden. The road between these two places passes through the most magnificent mountain scenery in Ireland, and, for part of the distance, close by the shore of the Killery, an extraordinary inlet of the sea, which is said to bear a very close resemblance to a Norwegian fiord. The Killery, though only about half a mile in breadth, is full ten miles long, and is hemmed in by mountains, which descend steeply to the water's edge. It would indeed be difficult to imagine it other than a fresh-water lake, were it not for the sea-weedy smell and the sight of seals swimming on its surface. Edward Forbes relates that, when dredging in the bay, he and his companions were much astonished to observe that the star-fishes and other animals, on being brought to the surface, seemed to be seized with convulsions. The reason of this they discovered to be that the upper stratum of water was *fresh*, being in fact the rain collected from the surrounding mountains, and prevented from finding free access to the sea, or from mixing with the lower strata of water by the contracted character of the basin. Of course the superficial layer of fresh water was quite sufficient to exercise a deadly effect upon creatures so sensitive to that element as star-fish.

If botany be the primary object, it will be advisable to make Roundstone our head-quarters for two or three days at least, and for a much longer time, if devoted to zoology. This little village is situated at the foot of the mountain Urrisbeg; it consists of a single straggling street, which runs parallel and nearly close to the shore of Roundstone Bay, a narrow creek separated from the much larger Birterbuy Bay by the Island of Inishnee. There is a comfortable little inn, and a much better supply of butcher-meat than is often to be met with in more accessible places in England. We had provided ourselves with a supply of Liebig's "Extractum Carnis" in view of any emergency, but Mr. Kelly, our host, paid good attention to the commissariat department, so that we were not driven to this resource. There is a Franciscan Monastery at Roundstone, the principal use of which is, so far as our experience goes, to supply boats to naturalists who want to dredge. There are about a dozen monks, who employ themselves in the tillage of the ground attached to the monastery, and in visiting the poor of the neighbourhood; and their residence has the aspect of being decidedly the snuggest and most comfortable place thereabouts. There are no public cars to Roundstone, but it is easily reached by hiring a conveyance from Clifden. The plan which we adopted on our last visit, was to go by the Clifden coach from Galway to Canal Bridge—the point of the road nearest to Roundstone—where Mr. Kelly's car was in waiting to take us up. The drive from Canal Bridge is very picturesque, the

"Twelve Pins" forming a magnificent mountain background, and every turn of the road bringing into view some new foreground combination of granite boulders, heather-clad hill side, moorland lough, or mountain torrent. In the space of two or three miles the photographer might find material for many a beautiful study, of a kind for which his art is well adapted. It may be noted that the roads, even in the wildest districts, are exceedingly good, though the traffic over them is so small, as often to call to mind one of Dean Ramsay's Scotch "Reminiscences"—A pedestrian in some unfrequented part of Scotland met with a man mending the road, and expressed his surmise that there must be very few travellers over it. "Eh," replied the stonebreaker, "it's no sae ill as that; there was a cadger body alang yestreen and there's yersel the day."

At a distance of five or six miles from Clifden, are situated the quarries from which the celebrated green marble or serpentine is chiefly derived. The formation in which this rock occurs is said by Professor Harkness to belong to the lowest series of the Silurian system, being of somewhat later date than the Laurentian rocks of America. Sir Roderick Murchison practically agrees in this view, but considers the so-called Laurentian rocks (we believe) not as a separate system, but as the base of the Silurians. The relative position of the two formations is, however, undisputed. Whether the *Eozoon canadense* has formed the groundwork of the Irish as well as of the Canadian serpentine must still be looked upon as an unsolved problem. The published evidence would lead us to believe that the Irish mineral is destitute of any visible organized structure, but we are inclined to believe that further investigation may reveal the existence of the Eozoon in a greatly altered condition. We imagine that after the admirably lucid drawings and descriptions of Dr. Carpenter, which appeared some months ago in the INTELLECTUAL OBSERVER, and taking into account the great extent and accuracy of his labours in that department of microscopical investigation, few will be disposed to accept the conclusions of Professors King and Rowney, as to the inorganic nature of the Canadian serpentine, though it may be freely admitted that, for the present, the organic character of the *Connemara* marble is "not proven."

The drive from Galway to Clifden cannot be called a particularly interesting one. For the first half or three-fourths of the distance, Lough Corrib is frequently visible, but its dreary shores never form a very attractive feature. The botanist may picture to himself the rare pond-weeds which inhabit its waters, but will find more gratification in keeping his eyes open for the ferns and other plants which deck the walls and banks

near at hand. In such situations, we noticed growing luxuriantly, *Ceterach officinarum*, *Asplenium adiantum-nigrum*, and *A. ruta-muraria*, besides others of more familiar aspect. *Osmunda regalis* is common throughout the district, growing in congenial situations to quite stately proportions. The tourist from the northern and eastern parts of England can scarcely fail to be struck with the free growth of exotics, such as fuchsias and hydrangeas in common cottage gardens. These plants are evidently perfectly hardy, the former making wood enough even to form hedgerows, which are often quite a-blaze with scarlet bloom. The reason of this may be found in the very equable climate enjoyed by this part of the island, the result chiefly of the warm Gulf Stream, whose waters impinge first upon the south and west shores of Ireland, after their passage across the Atlantic.

Among the botanical rarities of Connemara, the most beautiful and conspicuous are its heaths, and *facile princeps* amongst these is *Menziezia* (*Dabœcia*) *polifolia*. This splendid plant is very abundant in the mountainous districts, more especially on the hills round Kylemore Lake, where its showy spikes of crimson bells can scarcely fail to attract the attention even of the passing tourist. There is also a white variety, but it is somewhat rare. In the vicinity of Roundstone, *Erica Mediterranea* and *E. Mackaiana* are to be met with pretty plentifully, but they inhabit localities of somewhat limited extent. The former occurs abundantly on the sides of Glen Iskay on Urrisbeg, a mountain which rises immediately behind Roundstone; but as this heath flowers in April, and the others mostly from June to August, the collector need not expect to enrich his herbarium with flowering specimens of all. *E. Mackaiana* grows by the side of the road between Clifden and Roundstone, about a mile from the latter place. It forms beautiful shrubby patches, which, when we saw them in August, were covered with their lovely wax-like bells. *Erica vagans* is also said to have been found in Connemara; but of this we cannot speak from personal knowledge. The London Pride (*Saxifraga umbrosa*) is a frequent inhabitant of rocky mountain sides, and in similar situations the dwarf juniper (*Juniperus nanus*) may often be met with.

The partial analogy between the floras of Western Ireland and Spain is very interesting, and led Professor Edward Forbes to infer the existence, at some remote period, of continuous land between the two countries. The facts on which this inference was based are slender, but it is, perhaps, difficult to give a more satisfactory explanation of them. They are briefly as follows:—Several plants grow undoubtedly wild in the West of Ireland, which are not met with in any other locality

nearer than Spain or the south-east of France; the principal of these are the strawberry-tree (*Arbutus unedo*), which is so abundant and well-known about the Lakes of Killarney, the three Connemara heaths (*Dabœcia polifolia, Erica Mackaiana,* and *E. Mediterranea*), and two saxifrages (*S. geum* and *S. umbrosa*), but the last-named species is probably wild also in Yorkshire. Two other plants, *Naias flexilis* and *Inula salicina,* are common to West Ireland and Central Europe, and two more (*Sisyrinchium anceps* and *Eriocaulon septangulare*) to West Ireland and America, but the latter occurs also in the Hebrides. *Spiranthes gemmipara* appears to be peculiar to Ireland.

A glance at the ordnance-maps of the district shows an immense number of lakes. These are mostly surrounded by flat, boggy moorland, and have little or nothing to relieve them from the reproach of dreariness and unpicturesqueness, except that they contain numbers of small islets, which support occasionally a stunted growth of wood, thus somewhat relieving the bleak monotony of the scene. These small patches are, in fact, almost the only natural wood that is to be found in the west of Connemara. The rock comes so near the surface on the hill sides, that no trees could find a resting-place; and the country is so swept by strong west winds, that those planted in more sheltered spots seem to have a tremendous "struggle for existence." The one-sided stretch of their branches tells of the fierce Atlantic gales to which they are exposed. The lakes, however, which are so uninviting to the artist or the tourist in search of the picturesque, are full of interest to the naturalist. In almost all of them may be found abundance of the rare and curious *Eriocaulon septangulare. Lobelia Dortmanna* is also of frequent occurrence; *Utricularia intermedia* and *U. minor* are less common, as also *Alisma ranunculoides* and *A. natans.* In a small lake near the sea, and a little to the west of Roundstone, occurs *Naias flexilis,* first noticed by Professor Oliver in 1850. Probably a persevering search in some of the many lakes between Roundstone and Clifden would disclose its existence in other parts of that area. The sandy ground by the sea-side is the home of many interesting plants, amongst which we may just briefly note *Asperula cynanchica, Eryngium maritimum, Raphanus maritimus, Allium Babingtonii, Sedum anglicum,* and last, not least, *Arabis ciliata;* this, however, though not far from the sea-shore, does not grow on the sand, but in the crevices of granite boulders about a mile west of Roundstone. To find it will probably tax the patience and perseverance of the botanist. This fragmentary notice of the flora of Connemara must suffice us. We now turn to its marine zoology. But before entirely leaving *terra firma,* we may

recommend the naturalist to devote an hour or two to the ascent of Urrisbeg, if it were for nothing more than to gaze upon the extraordinary panorama of lake, mountain, sea, and islet visible from the summit. The mountain abuts upon an extensive plain, which stretches as far as Clifden on the north, the Twelve Pins on the east, and is bounded by the sea on the west. On this pefectly flat expanse, measuring some six miles by eight, is scattered a group of lakes (very diminutive, of course, many of them are) which, counted on the ordnance-maps, are in number about two hundred and twenty! These are all, or nearly all, visible from Urrisbeg; and it is evident that a very slight depression of the land would place the whole tract once more under the sea. Seaward stretches a string of islands terminating with the promontory of Slyne Head; to the south-west are the bays of Roundstone and Birterbuy winding up for miles into the mainland—and islets innumerable, of unpronounceable names. Inland the view is bounded by the fine mountain range of the "Twelve Pins," which, rising abruptly from the plain to a very considerable height, adds the element of grandeur to a scene otherwise most remarkable and interesting.

The "shore-hunting" in the neighbourhood of Roundstone did not appear to us particularly rich; but we had no means of getting information as to the best patches of rock for the purpose, and a stay of a few days is not nearly sufficient to investigate for one's self, seeing that only about a couple of hours of low-tide are available each day for the search. It is quite likely, therefore, that a more thorough acquaintance with the locality might much modify our impressions. The sandy beaches strike the eye at once with their unusual whiteness. An evening's walk to one of these—Gorteen Bay, a little to the west of Roundstone—revealed to us that the beach itself was almost entirely composed of broken-up and bleached marine organisms, of which foraminifera formed a very large percentage; but along with these, the microscope reveals many other things—valves of entomostraca, spines of echini and star-fishes, sponge-spicules, corals, and the like. Near high-water mark on this beach, where an abrupt ridge about a foot in height had allowed the lighter wind-swept particles to accumulate under its lee, we gathered great quantities of the "shell-sand," which is almost entirely free from unorganized material. It may be interesting to note the species of ostracoda contained in this gathering. They are as follows:—*Cythere aurantia* (Baird), *C. subulata* (Brady, M. S.), *C. angustata* (Münster), *C. emaciata* (Brady, M. S.), *C. avena* (Norman), *C. lævata* (Norman), *C. cellulosa* (Norman), *C. variabilis* (Baird), *C. viridis* (Müller), *C. contorta* (Norman), *C. convexa*

(Baird), *C. impressa* (Baird), *C. pellucida* (Baird), *C. inflata* (Norman), *C. placentula* (Brady), *C. scaphoides* (Brady, M. S.), *C. globulifera* (Brady, M. S.), *C. latissima* (Norman), *C. declivis* (Norman), *C. nigrescens* (Baird), *C. mutabilis* (Brady, M. S.), *Cythereis antiquata* (Baird), and *C. Jonesii* (Baird), besides other species not yet determined. Some idea of the wonderful richness of the sand may be gained when we remember that Dr. Baird's work on the British entomostraca enumerates only nineteen species of marine ostracoda, while the number here named as occurring in the Roundstone sand is twenty-three. The entomostraca, however, are but few compared with the foraminifera, which constitute the chief bulk of the sand. Of these, Dr. Alcock has found no less than sixty-four species, which are recorded in the "Proceedings of the Manchester Literary and Philosophical Society," vol. iv., p. 205.

Our stone-turning did not yield us much. An uncouth and ugly crab (*Xantho florida*) was abundant. *Doris tuberculata*, *D. repanda*, and some very fine specimens of *Fissurella reticulata* were the most noticeable things that occurred to us amongst mollusca, but these did not form a special object of search, crustacea, echinodermata and sponges being to us the chief attraction. The latter are represented on this coast by several fine species, amongst which we may specially name *Tethea lyncurium*, which is by no means abundant, but occurs somewhat sparingly in many localities. Connemara is, however, its only British habitat, unless we include the Channel Islands (Herm), where we found it in 1862.

The best dredging-ground in the Connemara district is probably Birterbuy Bay, which has the merit of being easily accessible from Roundstone, and of being tolerably well sheltered, so that, except in very foul weather, there is no difficulty in working it. The Bay of Roundstone itself is too shallow to be of much use to the dredger. The bottom is in many places covered with astonishing quantities of nullipore (*Melobesia calcarea*), with which the dredge completely fills itself in a very short time, and amongst this a handsome swimming crab (*Portunus corrugatus*) lives in considerable numbers. On the fronds of the nullipore the pocket-lens will also discover numerous adherent foraminifera, a class of organisms which one does not often get the chance of studying in their natural habitat. Their varied hues of green and brown, when seen thus living and filled with sarcode, give these animals an appearance very different from that of the bleached shells which mostly do duty in microscopic collections. Besides the nullipore first mentioned, Roundstone Bay produces another very extraordinary species (*M. agariciformis*), which grows in the form of a hollow, corrugated, or lichenoid ball, lying free

upon the bottom in about two or three fathoms water. This, however, we were not fortunate enough to find; but the rare cladophoræ (*C. Rudolphiana* and *rectangularis*) are common enough. The existence of many other wonderful algæ found here by Mr. M'Calla we had to take for granted, not having time to devote to a search for them. Amongst these we may specially mention *Codium amphibium* and *Callithamnion triapinnatum*, both of them treasures, the sight of which would have gladdened our eyes.

Running round the seaward point of Inishnee, where we usually feel something of the force of the Atlantic waves, we are soon in the comparative shelter of Birterbuy Bay; here we may put down the dredge in good earnest, and if it be our first scrape, wait in a state of delicious excitement for the result. Our first haul produced a splendid lot of sponges—things quite new to us, and glowing with varied colouring of yellow, red, and brown. But besides these there was a fine specimen of the splendid star-fish, *Uraster glacialis*, a species which yields to none in richness of colouring and beauty of aspect when living, but which is, unfortunately, most difficult to preserve well, either as to form or colour. One magnificent specimen of this uraster we found to measure thirty inches in diameter from tip to tip of the rays. This, however, was the only noteworthy star-fish which occurred to us, though the dredge often came up loaded with commoner species, such as *Ophiocoma nigra* and *rosula*. A fragment of a ray of *Luidia* once came up, but this was the only indication of the presence of that beautiful species. Of sea-urchins we took only *Echinus esculentus*, *E. miliaris* and *Echinocyamus pusillus*, concerning which last, it may be noted that it is not, when living, "pea-green," as described by Forbes, but grey, changing to green on exposure to the air, or after immersion in spirit. We need scarcely pause to enumerate the various crustacea, mollusca, etc., dredged in Birterbuy Bay; they are mostly well enough known. Amongst the most interesting of the former class, we may mention in passing, *Atelecyclus heterodon*, *Portunus arcuatus* and *Xantho rivulosa*. We were fortunate enough to obtain one dead specimen of the rare and beautiful shell, *Tellina balaustina*. We were, however, unsuccessful in our endeavours to secure living specimens from the fine colony of *Akera bullata* discovered by Dr. Farran, though we spent a good deal of time in trying to hit the right spot. For the benefit of future explorers we transcribe an extract from Dr. Farran's account of his discovery*:—

"Running down Birterbuy Bay until we opened on Round-

* Abridged from Natural History Review, vol. iv., 1857 (Proceedings of Societies), p. 75.

stone, and altering our course, we got under shelter of the high-land of Inishnee. Having proceeded a considerable distance up this creek, we found water as still as a mill-pond, although a storm was raging above us, and as our speed was slackened, I thought I might as well try the dredge, and accordingly threw it overboard, and had it under weigh for two or three hundred yards, when we found ourselves fixed between two ledges of rock, and embedded in a sludge of mud and decayed or decomposed nullipore. Having ascertained that no damage was done to the vessel, my first care was to have the dredge brought on board, and my surprise was great, when fifteen egg-like substances, and fully as large, rolled on the deck; the resemblance to duck-eggs, mottled with brown and purple spots, as if incubated for some time, was most striking. At first sight I took them for some undescribed species of doris, but on keeping one of them in my hand, I found that it gradually elongated and exposed the apex of the spire, but of such size that I entertained doubts as to its identity with akera. The measurement of the largest when first taken was as follows:—three inches in length, and two and a half in diameter, and the weight, when we reached Roundstone, one and a half to two and a half ounces. . . . . The men having extricated the vessel from her unpleasant position, I prevailed on them to make several tacks in hopes of securing more specimens of this prize. This they did, but without success, having kept close to, but outside, the rock, the water shoaling and the tide receding, preventing us from keeping in our first course. Finding our efforts vain, and the wind lulling, we took the opportunity and returned safely to Roundstone. On giving the matter further consideration I came to the conclusion that the akera lived here in shallow water, for I had not more than two fathoms of rope when I first threw out the dredge. I reflected that whatever power the wind exercised, blowing as it did from the land, assisted by the receding of the tide, tended to drive the vessel from the shore; consequently when we reached the rock, we were considerably outside the line where *Akera bullata* lived. . . . . Having this conviction in my mind, the next day I procured a boat carrying a small lug sail, and drawing less than eighteen inches of water, and steering to the ground, I had the satisfaction to find that my calculation was correct; for on dredging over the ground laid down in my mind's eye, within the rock, and closer to the shore, the tide being full in, I obtained as many of those magnificent specimens as I desired." This account is very interesting, as exemplifying the exceedingly partial distribution of species, it being quite a common occurrence to take a large number of a species in one haul of the dredge

and to fail in every subsequent attempt, apparently on precisely the same spot. Possibly by paying particular attention to the description of the locality in which Dr. Farran found these gigantic specimens of akera, some future dredger may be more fortunate than ourselves. The tide was low when we were on the spot, and time did not allow of a second attempt.

The islands of Arran deserve a few words of notice before closing this brief sketch. They are easily reached either from Galway or Roundstone, being about equally distant from both places, and in fine weather the sail down Galway Bay, or amongst the islets lying off the western coast, is very delightful. Arranmore, the largest of the group called the Isles of Arran, must be an interesting spot either to the naturalist or the casual visitor. In the one case the richness of its fauna and flora, and the peculiarities of its physical aspect; in the other, the curious customs of the islanders, now fast fading away before a freer intercourse with their neighbours, form subjects for study none the less instructive and amusing for being so close to our own doors. Of the marine zoology of the island we have nothing to say, as the weather became stormy during our brief visit, and thus put a stop to dredging.

Our first care on landing was to refresh the inner man at the Atlantic Hotel (do us not the injustice, kind reader, of supposing that our thirty miles' voyage had produced a vacuum in the gastric region); this done, we turned out for a stroll along the beach, with the special object of securing a few roots of the maiden's-hair and sea spleenwort. The seaward face of the island is made up of a succession of limestone cliffs, separated from each other by intervening terraces of quite bare, horizontally-stratified limestone. On the promontory which supports the lighthouse a series of about thirteen of these steps may be counted, beginning at the present sea level and continuing up to the summit of the hill. Whether the terraces may be really "raised beaches," I cannot pretend to say, but at a distance they have, to the eye, precisely that appearance; they are of considerable extent, probably, often one or two hundred yards in width, nearly as flat as a street pavement, and split with innumerable vertical fissures, mostly from two to four feet deep, and from three to twelve inches wide. In these fissures, protected from the wind, and warmed by the radiation of heat from the surrounding limestone, many species of wild plants grow with astonishing luxuriance; *Asplenium marinum*, and *Adiantum capillus-veneris*, especially attain a gigantic size, and of both of them we obtained noble plants, with fronds nearly two feet in length. In company with these grew also with like luxuriance *Eupatorium cannabinum*, *Geranium robertianum* and *sanguineum*, *Rubia peregrina*, etc. But

though the *Adiantum* growing in the perpendicular fissures just mentioned is so splendid in point of size, its real beauty is much greater when clothing a shallow horizontal fissure in the face of a perpendicular cliff. In such situations it fills the cavity, perhaps yards in length, with an unbroken mass of indescribably lovely green; a sight, indeed, which it is worth a journey to see. Long may the cliffs of Arranmore remain unmolested by the profane hands of nurserymen.

Amongst many interesting plants observed on the island within a short distance of the little village of Kilronan were the following:—*Orithmum maritimum, Orobanche hederæ, Galium pusillum, Arabis ciliata, Beta maritima, Amaranthus blitum, Hypericum androsæmum, Verbascum thapsus.*

A curious custom, seemingly now almost extinct, amongst the islanders of Arran, is the erection on the roadsides of monuments to the memory of the dead. These are all formed on one pattern, and consist of a square column, about eight feet high (speaking from memory), built up of the laminated limestone of the district. Into one side of the column are cemented two tablets, the upper of which bears an inscription, such as the following: "Lord have mercy on the soul of Denis Flaherty, who died September 8, 1834, aged 54 years;" the lower sets forth the names of those who erected the pillar, thus: "This monument was erected by his brother Ambrose, and his sons Patrick and John." The latest date which we observed on any of these memorial pillars was 1840, and we were told that they are now seldom or never erected.

THE WAXWING, THE PINE GROSBEAK, AND THE CROSSBILLS.

BY "THE OLD BUSHMAN."

THESE three birds, denizens of the far north, are rarely seen in a state of nature by the British naturalist; but, when once seen, are easily known, for two of them can perhaps lay claim to being the most beautiful birds in the European fauna; while the singular conformation of the bill in the third has been regarded as an unfortunate monstrosity by those naturalists who would not give themselves leisure to reflect that the awl-shaped beak of the humming-bird, the thick, unwieldy bill of the toucan, and the beautiful mechanism of the mandibles of the crossbill, are all peculiarly adapted to the habits of their possessors, and were all planned by that Great Workman who has never yet been known to make a mistake. It is natural, therefore, that the young ornithologist should wish to know something of the habits of three birds whose very variety renders them interesting, and respecting which mysteries but lately cleared up have so long existed. And as, during a long residence in the north of Europe, all three have been my familiar companions, and as my remarks are the result of personal observation, I venture to lay them before the readers of this journal.

We will begin with the waxwing, or, as it is sometimes very erroneously called, the Bohemian chatterer. I consider the name "waxwing" as well applied; but what right or title it has to the names either of "Bohemian" or "chatterer," I cannot guess, for it does not appear to be peculiarly a native of Bohemia any more than of Britain; and it is one of the quietest birds I know, never uttering a sound save a low, hissing twitter, and even this is seldom heard, except when a flock of them sweep down in winter on to the top of a mountain-ash tree. In the summer, or in confinement, they rarely utter a single note. The beautiful silken appearance of the light reddish-grey body-plumage, the splendid wings, and, above all, the peculiar wax-like appendages on the ends of the shafts of the secondaries, render the waxwing a very conspicuous bird; and although there may be many others with more strikingly gaudy plumage, I much doubt, take it altogether, whether there is any European bird in which the colours are more beautifully arranged than in this. Rather less than the starling, which in its flight it much resembles, the waxwing is a tame, familiar bird, exceedingly voracious; and although a common cage-bird in Sweden, it has little to

recommend it, for the plumage soon becomes soiled and dirtied in the cage, and the bird has not a single note of a song. The breeding-home of the waxwing is within the Polar Circle, and I do not believe any truly authentic nest has been procured farther south than the one which I brought down from Quickiock, in Luleå-Lapland, in about lat. 67° 20″ N., in 1862. The breeding habits, as well as the breeding localities, of the waxwing were long a mystery; and I believe the first really authentic nest sent to England was taken by some Laps, and sold to the late Mr. Woolly in 1855. This contained five eggs, two of which were sold by auction in London for £5 and £5 10*s*. I had the egg in my collection as long back as 1848, but as it was not authenticated, I placed but little value on it. Upon comparing it afterwards, however, with the genuine egg which I brought down from Quickiock, I found it was to be depended on. Since then the nest has been taken in many places, both in Lapland and Finland—principally, however, in Finland; always, as far as I can hear, within the Polar Circle, and the egg of the waxwing is no longer a rarity. As, however, many collectors have never seen the nest and egg of this bird, a short description, from that in my collection, may not be uninteresting. The nest is large, and clumsily-built of reindeer moss and small dead fir-twigs, mixed plentifully with the *Usnea Barbata*, a dark, coarse kind of lichen which grows commonly on all the fir-trees in the Lap forests, and lined with a few fibres of dead grass. The eggs, five or six, nearly as large as those of the common bunting, but shorter; ground colour pale bluish white, thickly speckled all over with purple, black, and brown spots, leaving the ground colour of the egg very visible. They go to nest early in June, and at this season the birds are exceedingly shy and still, so it is very difficult to discover the locality; and the old female flies like an arrow off the nest as soon as she hears any one approach, and does not return for a length of time. The nest is placed either in a fir, pine, or birch, never very high from the ground; and although when one nest is found, others are pretty sure to be at no *very great* distance; the waxwing can hardly be called gregarious in its breeding habits.

It is hard to distinguish the male from the female by the plumage, except that the colours in the male are always bolder and clearer. Old Aldrovandus says that the female has twelve tail feathers—the male only ten. I have examined many undoubted males, and all had twelve tail feathers; and the only female which I was certain of (for I proved her by dissection) had only ten, but this might have been accident. It will be a most curious as well as interesting fact, if future examination should prove this difference to be constant.

The breeding range of the waxwing extends, probably, much to the east of the Tornea River, perhaps into Siberia. The bird is, however, hardly known up at the North Cape; and I never saw one in the middle of Sweden after April. About the very end of October, or beginning of November, large flocks come down from their northern breeding haunts into the middle of Sweden; whether driven down by the inclemency of the weather, whether in search of food, or from what other cause, we have no means of guessing. I may add that these winter migrations appear, however, to be as uncertain as the summer migrations; for the birds do not always in the same years breed in the same tracts, nor do they come down from the north in the same quantities in every year. In many years, when we have plenty of mountain-ash berries, we see few, if any, waxwings; and in others, when scarcely a rowan-tree has fruit, we see plenty feeding on the juniper-bushes. It is not altogether either the severe weather that drives them down, because often in a very severe winter we see no waxwings. But one thing I have remarked—the appearance of the first flock of waxwings in the middle of Sweden always heralds in the first deep fall of snow. It is certain, that of late years their numbers have much decreased. I have not seen any really large flocks since 1850, when they came down to us in such quantities that I killed as many as twenty-seven out of the same flock at one shot. Since that year, they have not appeared in any quantities; and as the same remark applies to the fieldfares, redwings, and all other of our autumnal migrants, which are shot and sold for the market, and go here by the name of "Kramsfogel," I think the diminution of their numbers may be attributed to the increase of "pop-shooters;" for where one boy carried a gun fifty years ago, twenty do now, and the birds are cleared off at every resting-place on their road down from the north. I never, however, could rightly make out what became of all the large flocks which used to come down into the middle of Sweden every autumn. Very few were ever met with, comparatively speaking, in the south of Sweden; and we all know the waxwing is only a very occasional visitant to Britain; yet, although we used to kill hundreds here, still hundreds passed on, but which direction they took on leaving us we could not confidently say, but we always supposed south, because, whenever they were numerous, with us, we used to hear of large flocks in every other part of the country, both to the east and west; and yet, whenever they returned in the spring, it was only as stragglers, or in very small flocks, probably containing not one in a hundred of those we saw on their way down. Although they can also feed on the juniper, as well as pro-

bably on many other berries, and in the spring even on the new rye; as long as the mountain-ash berries last these appear to form the principal food of the waxwing in autumn; and, as they travel down the country, they strip the trees bare. This is always done before Christmas, and we see no more of the birds again till about the end of March or April, on their return to their northern breeding haunts. What becomes of them during this period I could never make out.

In the summer, I fancy, the waxwing is purely insectivorous. In the cage they will eat many berries, and are very fond of bread soaked in milk; but they are very apt to die of fat, and they must be kept in a cold room. However, as Bechstein says, nothing but its scarcity and beauty can render the possession of the waxwing desirable, for it is a dirty, stupid, lazy bird. It is singular that, out of the many hundreds which I have shot, I never by any chance fell in even with a stray example of the cedar-bird (*Ampelis Americana*), which represents our waxwing in America. This latter bird may at once be distinguished from the European waxwing by its smaller size, and the total absence of white or yellow on the wings, which are of an uniform slate colour. Of late years the European waxwing has been discovered near the Rocky Mountains, in America; and as it has also been killed in Japan (which latter country, however, owns a third species which has no wax-like appendages on the wings), our European waxwing will be seen to have a very wide geographical range.

Although, perhaps, the plumage is not altogether so brilliant, there is little to choose between a fine old deep red male grosbeak and an old waxwing. In fact, without being so varied, I fancy the body colour of the pine grosbeak the richer of the two. The pine grosbeak is another bird whose peculiar breeding-home in Europe is within the Arctic Circle; and, although I met with them breeding much more commonly at Quickiock than the waxwing, I do not believe that the nest has ever been taken farther south. This is another of those northern birds which in winter migrate from their breeding-places in the far north, and at this season they are occasionally seen even in Britain. These migrations do not, however, appear to be nearly so regular as those of the waxwing, nor do the birds ever appear in such flocks. I fancy that some remain in Lapland all the year, which I do not believe is the case with the waxwings. Whenever they do come down into the middle of Sweden, we see them earlier than the waxwings, and they always leave before Christmas; and we never by any chance see any in the spring, on their return to the north. Of the same genus as the crossbill, there is some little similarity in the habits of the two birds, although they never seem

to associate in the forest. Both have one peculiarity in common, which I have observed in the lowries, and some other Australian parrots, which is, that neither of them attain their full red plumage until after the second, or, perhaps, the third moult. In the year after its birth, when the male grosbeak first breeds, there is very little difference in plumage between the male and female. The body-colour in both is ash grey; in the male slightly tinged with red, most on the breast, head reddish yellow. In the female the tinge on the head and breast is much more yellow, and this is the only difference between the plumage of the two sexes in the second, and, perhaps, even in the third year. This is the usual dress of the female at all ages. About the third year the male assumes his gorgeous red livery, which he probably wears for some length of time; but, at a very advanced period of life, the old male grosbeak, like the crossbills, changes from red to bright yellow-green. Although a thick-billed bird, like the crossbills, we rarely see the grosbeak feeding either on the fir or pine-cones. Their principal food seems to be the small buds on the fir-branches, and they also eat juniper and rowan berries. In confinement they are very fond of bread and sugar, juniper berries, oats, and canary-seed, and they drink a great deal of water. The pine grosbeak goes to nest about the middle of June. The nest is placed both in pine and fir-trees, and never at any great height from the ground. It is one of the neatest and most compactly-built nests of any of our northern forest birds; not very large, but very cleanly built, like basket-work, of fine fir-branches and thin fibres of the cranberry, tightly interlaced, lined with fine grass and a little hair. The eggs vary much, both in size and colouring; usually about as large as those of the hawfinch, but a little thinner; ground-colour pale blue-green, blotched and streaked with light purple and burnt umber spots and frecks; usual number of eggs, four. Both male and female are very quiet during the breeding season, never uttering any note save a gentle cluck, and never betray the locality of the nest by any undue anxiety. The sweet, flute-like note of the male bird, which we have previously heard nearly all through the clear light northern spring night, is now entirely hushed, and he attends most assiduously on the female, assisting her both in building the nest and in the care of the young. The note of the pine grosbeak is one of the loudest, wildest, and most beautiful that I know, almost too powerful for a room, and unlike that of any other bird which I have ever heard. To hear it in perfection we must seek the deep solitudes of the Lapland forest, and here, in the soft twilight, which may be said to last nearly the whole night, the wild carol of the red-

wing and the rich, mellow gush of the pine grosbeak's song form a concert which, when once heard, can never be forgotten.

The grosbeak appears to be one of the stupidest of birds. I have actually seen little boys noose them one after the other with a long pole and a horsehair snare from the trees on which they were feeding.

We now come to a bird whose habits are much more familiar to our readers, and one which has a far wider breeding range, for the nest of the crossbill is not unfrequently taken in Scotland; and, although it may be considered as rare within the Polar Circle, yet it is known to breed in almost every other part of the Scandinavian continent. There was long a mystery attached to the breeding habits of the crossbill, which it was my good fortune to clear up. It was said that these birds bred at no certain periods, but that the nests were found at all seasons, from December to June; moreover, that the winter nest differed from that of summer, being covered, like that of the wren, with a little hole at the side for the old bird to enter. Now, it is true that the crossbill is the earliest breeder of all our northern birds, but still it has its regular period, the same as any other. I have now watched them for years, and I have always found that they begin building about the middle or end of February, according to the season; in fact, I once took a nest as early as the 14th of February. In April we see strong flyers, and after the first week in April I never saw a nest with eggs. I never saw a covered nest—all the nests I have seen have been open; and I rather wonder at this, for at the time the crossbill breeds the weather is always most inclement, and one year I saw several nests in which the young birds lay frozen to death. Like the grosbeak, I have now satisfactorily proved that the male crossbill does not attain the deep red plumage till the second, or, I think, most probably the third autumnal moult after leaving the nest; certainly not at the first, as has been erroneously stated by most naturalists. I fancy they also undergo a partial moult in May. The habits of the crossbill are very puzzling. With us they all leave the district in which they were bred as soon as they can flock, and we rarely see any in the summer in those years when they breed with us. It is not in all years that they breed in the same forests; and I think this entirely depends upon the state of the fir-cones, for these do not ripen in the same districts every year; and as it is on the seeds of the fir and pine-cones that the crossbills exclusively feed, they are obliged to seek those forests where the cones are in a fit state to yield seed. When they do breed with us, they make their appearance in the autumn, and I have generally re-

marked that in such years we shall have very little snow. They keep about the forests in small flocks throughout the winter; and were it not for the difference of the landscape, we might almost at this season fancy ourselves in a southern forest, as we watch a little flock of these birds busily feeding, flitting from cone to cone, or climbing over them with their backs downwards like the parrots, their bright red or orange plumage reflected in the rays of the afternoon sun, which, even at this inclement season, gilds the tops of the firs for an hour or two before sinking into the west.

The pairing season begins about the middle of January, when both sexes have a very pretty song. Old Aldrovandus had remarked this, for, when speaking of the crossbill, he observes, in his quaint style, "One thing, also, more seemeth to me strange and unusual in the crossbill—that in the winter-time, when all things shrink with cold, and other birds are mute, she sings; and in summer, when other birds sing, she is silent. Which, whether it be true or no, let those observe among whom such birds are common. It sings, they say, very sweetly." Right, old man; they have a very pretty song, which I never heard except in the winter. The male assists the female very little in the building part of the business. All he seems to do is to sit on a high fir, close by where the female is making the nest, and cheer her with his song. Thus, the nest of the crossbill is very easy to find by any one who is in the forest early in the morning. The nest is placed almost invariably in a small pine (rarely in a fir), close to the top, right into the stem; never in a deep forest, but always, with us, on a small stony rise, where the trees are small and wide apart. The nest is thick, and clumsily built outwardly of dry fir-sticks, lined thickly with grass and moss. The eggs exactly resemble those of the green linnet, but are considerably larger. Although not gregarious in their breeding habits, like the rook, you never find one nest without others being in the neighbourhood. The breeding habits of the parrot crossbill much resemble those of the common bird, but the nest and eggs are larger, and they always go to nest a fortnight after the common crossbill. The full number of eggs I take in both to be three. I never heard of the white-winged crossbill breeding in Sweden, although it is occasionally shot here. I have shot a beautiful variety of the common crossbill here, with two faint rose-coloured bands on each wing. This variety is called by Brehm the *Loxia rubrifasciata*.

I have thus endeavoured to give a slight account of the breeding and other habits of, perhaps, three of the most interesting birds in our forests.

The study of ornithology has always been a favourite one

with me, and is one of the few innocent pleasures of youth which follows a man into maturer years, and upon which he can look back in the decline of life with feelings of pure and unalloyed joy. Man's constant companions in every out-door occupation, cheering him with their plumage or their songs, affording him often a principal means of subsistence—it is little wonder that the study of the habits and instincts of birds should be a favourite one with all; and to him whose time is quietly and happily spent in the forests and the fields, it adds one of the truest zests to rural life.

ON THE STRUCTURE AND CIRCULATION OF NITELLA TRANSLUCENS.

BY THE REV. FRED. HOWLETT, M.A., F.R.A.S.

(*With a Coloured Plate.*)

In an article in the Intellectual Observer of April, 1866, treating on the development of the ova of the common newt, the writer observed, that if the ova be allowed to be deposited among the slender and highly transparent sprays of the characeous plant *Nitella translucens*, some of the most striking instances of both vegetable and animal circulation might be witnessed at one and the same time, without any further preparation than merely placing the plant and ova in a glass trough, and submitting them to the microscope; and the concluding page contained this remark: "But in connection with the circulation of nitella, including also the remarkable phenomenon of spontaneous movements exhibited in the process of fertilization and fructification, so many beautiful and singular facts stand forth, that it may well be worth while to make them the subject of a separate paper." This, then, it is our purpose to do in the article before us.

The ordinary botanist may very possibly not have included the humble submerged aquatic plant, now to be described, within the range of his investigations. It is not very commonly met with; and, when found, as seen by the unaided eye, there is not much to recommend it. Its flowering organs, if so they may be called, are but barely visible; nor is it possible to preserve it in one's herbarium. In its fresh and growing state it has, indeed, certain elegant characteristics, which, perhaps, will not have escaped the notice of one who may be a disciple at the same time both of Isaak Walton and of Linnæus; if, after having hooked some of it up from pond or lake, he may have deemed it not unworthy of a passing

NITELLA TRANSLUCENS.

(Natural size.)

a. b. Portions of Stem, (as at A. B.) mag. 25 diam. *f'* Antheridial Filaments, with immature Antherozoids, 450 diam. *f'''* Mature ditto, 450 diam. *g* Detached Antherozoid, after Dr. Carpenter, about 800 diam. *i* Nucule seed.

glance. Its odour, truly, is not prepossessing, for it bears about with it a sickly scent of the quintessence of mud; but the glossy transparency of its filamentous emerald-green sprays is sufficient to distinguish it as something curious. And if, moreover, he may have brought some of it home in water, and viewed it in that element under the microscope (especially if furnished with its minute organs of fructification), he would probably consider that to have been a well-spent hour which made him acquainted with the circulation and details of structure of *Nitella translucens*.

The plant now alluded to is an inhabitant of quiet waters possessing a muddy, or rather, perhaps, clayey bottom. Several species of characeous plants are indigenous to Great Britain, but some of them have such a constant tendency to be encrusted with a coating of carbonate of lime, that the features about to be described are far less easy of investigation in their cases, though they really exist in all the species alike.

When the encrusted species can alone be met with, it will be necessary to remove carefully the opaque matter; though if these even be kept some few weeks in rain or other water free from lime, they will soon send forth young sprays of tolerable transparency. Fortunately, moreover, the curiosities attendant upon the fructification may be almost equally well seen in all the species alike. By some writers the charæ have been classed along with the algæ; though others consider that the peculiarities of their method of reproduction bespeak for them a higher position in the vegetable kingdom. They are all, as we said, aquatic plants, presenting in their growth elongated thread-like tubes, from which at intervals spring whorls of other tubular branches, which, in their turn again, are similarly subdivided. (See Coloured Plate.)

In some species, as in the one before us, the tube is simple, but in others it is compound; that is to say, the tube is closed with a cortical or bark-like layer of smaller tubes, so that in a transverse section it would present the appearance of a large circle surrounded by a number of smaller ones. Upon this difference, indeed, some authors have founded the two different genera of chara and nitella, though other careful writers do not consider that this distinction merely is sufficient warrant for their separation.

When the species is of the cortical kind, as in *Chara vulgaris* and *Chara aspera*, the subordinate tubes are arranged spirally round the primary one; but in those which, like nitella, possess only simple tubes, the transparent cell-wall is lined internally with a single closely-set layer of roundish or oblong granules of chlorophyll, the direction of whose spiral arrangement is observable by means of a singular break in

their continuity, exhibiting itself as a narrow transparent line of light, passing in a curvilinear manner down the tube. These particulars may be seen in those of our Figs., which, on a larger scale, represent those portions of the plant which are respectively enclosed in the small square spaces, A and B.

Within the tubes, under a magnifying power of 60, but better still of 120 diameters, may be seen to circulate wavy-looking masses of unorganized fluid, and innumerable minute circular granules, and also numerous spherical corpuscles of much larger dimensions, all of which are embedded in a stratum of transparent semi-gelatinous matter, called the circulating protoplasm, and by which they are carried along, first obliquely up one side of the tube, then round its circular extremity, and so obliquely down the other side to the other extremity.

This motion is of a particularly smooth, sedate, and measured description, presenting a striking contrast to the more hurried and pulse-impelled circulation of the blood-corpuscles, as seen in the transparent portions of the young newt or frog.

In vallisneria, too, as is well known, the circulation is also extremely beautiful, and probably better known than that of nitella. It is, however, more difficult to exhibit, not only because it is necessary to slice off a portion of the leaf in order to expose the cells, but also because, being of a more sensitive nature, it is often some little time before the portion operated upon recovers from the shock and resumes its circulation.

In nitella, indeed, if a tube be injured in any point, the circulation in that particular tube instantly and permanently ceases, though it will continue with unabated activity in all those portions of the plant which lie above and below the damaged filament. During winter, as might almost be expected, the circulation is very sluggish, and, indeed, barely perceptible, unless the plant has been for some time kept in a warm situation.

If, as it may sometimes be managed, one small tube of a whorl be carefully torn away from its socket, the wounded extremity which will then be exposed will be seen to be bounded by a cell-wall of such extreme thinness and glassy transparency, that the whole of the circulating contents of the tube may be observed with still greater facility. Under these circumstances the surface of the larger circulating corpuscles will be seen to be far from smooth, but thickly beset, often with minute sharp spines, very much after the manner of the pollen grains of a mallow, or major convolvulus (see Fig. *b*).

These last appendages are still more indisputably apparent

when the contents of a tube of nitella are carefully squeezed out from one of its cut extremities upon a slide of glass; and, perhaps, most of all when an aqueous solution of tincture of iodine has been applied to the same, when the globules and their spines will stand out a deep orange red, the chlorophyll granules assuming a purplish brown tint. The protoplasm itself does not seem to be affected by the re-agent above mentioned.

It may be mentioned, in passing, that if the protoplasm extruded from the tube of nitella be simply left to dry upon the glass slide, it will crystallize in minute arborescent sprays, not unlike those assumed by the metal produced by precipitation from a solution of crystallized nitrate of silver, which forms such a beautiful opaque object for the microscope.

Some grains of *Tous les mois* starch exposed by the writer to the iodine by way of contrast, immediately assumed that amethystine blue so characteristic of the chemical effect of iodine upon amylaceous matter.

A rather strong solution of acetic acid did not, for some time, affect the colours of the globules, nor the definition of the spines, beyond rendering them somewhat paler. By degrees, however, the spines seemed to dissolve, and the globule generally became indistinct. These spine-globules (which, from their somewhat high organization, may be presumed to play some important part in the economy of nitella) vary in size, as carefully measured by the writer, from about the $\frac{1}{1500}$th to as much as the $\frac{1}{600}$th of an inch. The minute protoplasmic granules are only from the $\frac{1}{10000}$th to the $\frac{1}{6000}$th; and the chlorophyll granules, lining the tubes, from about the $\frac{1}{3000}$th to the $\frac{1}{1500}$th of an inch.

For such minute measurements, if any observer does not possess or know how to use a regular micrometer, a very good approximation may be arrived at by comparison of the object under investigation with the convenient standard of the human blood corpuscles, which possess a mean diameter of $\frac{1}{3300}$th of an inch.

But we must now pass on to the description of the highly curious organs of fructification exhibited by nitella, and all the characeæ; and the whole of which may be very well investigated by a good $\frac{4}{10}$ths or $\frac{1}{5}$th object-glass.

At the axils of the more terminal sprays of the plant (see general Fig.) may be found, all through the summer and autumn months, certain small brownish bodies, of two descriptions, which are commonly found grouped together, and which are called respectively *globules* and *nucules*. The globule, which, as its name suggests, is circular in form, fulfils a function similar to that of the so-called antheridium in ferns and

many other cryptogamous plants, and which, there is little or no doubt, is the same as that of the *anther*, with its fertilizing pollen, in the ordinary flowering or phanerogamous plants; whilst the nucule, which is of a more elongated form, serves the part of the archegonia, in the former class of the vegetable kingdom, or of the *pistil*, with its germ-cell, in the latter class.*

The exterior coat of the globule is transparent; but the interior, when mature, is of a brownish red or orange hue, and presents a singular and elegant construction. It is composed of separate triangular plates, eight in number, each of which is again composed of several long, transparent, wedge-shaped cells, radiating from a common centre, and containing numerous small granules of colouring matter about $\frac{1}{1000}$th of an inch in diameter, and which impart their own hue to the whole globule. The edges of these plates are rather deeply crenated, by which means they at first are fitted one to another, like a piece of marqueterie. But when the globule, on becoming mature, has burst asunder, a spindle-shaped cell will be seen to project from the interior surface of each of the plates, directed inwards, and meeting at the centre of the globule similar cells projected from the other associated plates, and which might perhaps be suggestive of a fantastic fairy parasol! (See Fig. *e*.) After these plates have fairly separated, the contents of the globule will be seen to consist of numerous slender, cylindrical, transparent filaments, about $\frac{1}{2500}$th of an inch in diameter (see Fig. *f*), and subdivided into separate short cells, each of which contains, and finally discharges, a delicate, spiral, filiform, antherozoidal body, which (like those of the ferns, mosses, etc.) continue to swim about actively for some time in the water, lashing themselves along by means of apparently two long cilia with which they are furnished. Before arriving at maturity, the antherozoids appear as small, oval, gelatinous masses, which gradually pass into the filiform shape previously mentioned. (See Figs. *f'* and *f''*.)

The *nucules* are not less singular than the *globules*. They consist of a single germ-sac, enveloped by five cylindrical tube-cells, which, springing from the bottom of the sessile *nucule*, coil spirally round it, until, upon meeting at the top, they there slightly diverge again, so forming a sort of open crown, down which the antherozoids find their way, it is believed, into the germ-sac (which contains both protoplasm starch and oil, according to Griffiths and Henfrey), and which, upon thus being fertilized, developes a curious dark-brown seed, characterized, also, by sharp spiral ridges winding round it, and which, falling to the bottom of the water, gives rise to

* See Intellectual Observer for February, 1865, p. 36.

a fresh plant. It is said that the charæ are also multiplied by *gemmæ* (that is, easily-detached *buds*), which grow out at the articulations of the sprays.

The circulation may also be often well seen in the spiral tube-cells composing the exterior of the *nucule*.

Nitella has not only regular roots, whereby it is moored to the bottom of the water, and from whence, probably, it derives its chief nutriment, but it is also furnished with numerous extremely slender subsidiary root-filaments of not more than the $\frac{1}{1500}$th of an inch in diameter, extending one or two inches, often, in length. These may soon be observed to grow out at the joints of any portion of a plant which may be suffered to remain undisturbed in an aquarium, and whereby alone it may be maintained in healthy growth. They are perfectly transparent, and, being devoid of any chlorophyll, the circulation therein is as plainly apparent as if going on in a glass tube. The protoplasmic globules, however, are but sparse, and much more minute than those of the stem and sprays; few, if any, observed by the writer being larger than the $\frac{1}{4000}$th of an inch, and the majority not more than the $\frac{1}{10000}$th.

Lastly, whilst searching for nitella in the waters of the Weald of Sussex and Kent, it is highly interesting to think how, in geological ages long since rolled away, this humble and fragile plant maintained its own amidst the ancient floods and dire forms of the saurians and pterodactyles of certain members of the Wealden group comprehended within the Secondary rocks of the cretaceous formation.

For whilst, as we are informed by Sir Charles Lyell,* that the flora of the Wealden was anciently characterized not only by an abundance of coniferæ, cycadeæ, and ferns, the spore-vessels, or seeds, of the chara also were discovered, in 1855, in the Hastings sand-beds of the Isle of Wight—a point, this, of some importance, inasmuch as it supplies a link between the Secondary and Tertiary flora which was previously wanting. Because, according to the same author, these spores are also found embedded in the flints of the extinct volcanic district of Cantal, in Auvergne, in Central France, in connection with Tertiary fresh-water formations of the miocene period.†

A few years since, curious spiral fossil seeds were quite a puzzle to geologists, some of whom imagined them to be foraminiferous shells, and by whom, before their true nature was ascertained, they were called, from their peculiar form, *gyrogonites*.‡

In conclusion. Here, in the existing waters of the

* *Elements of Geology*, Ed. 1865, chap. xix., p. 350.
† *Ibid.*, chap. xiv., p. 229. ‡ *Ibid.*, chap. iii., p. 31.

Wealden, we find these plants and seeds abundant still, nestling in the quiet depths of ponds hollowed out in formations which contain the *fossil* remains of closely allied species, so ancient, however, that they must have grown in ages which preceded that prodigious period of time required for the abrasion of the whole of the overlying chalk which intervened between the North and the South Downs; and before the consequent denudation of the Wealden beds of the Isle of Wight; where, as we have seen, they have of late been discovered by the microscopist and geologist.

NEW FACTS IN BOTANICAL GEOGRAPHY.

BY EDMUND BOISSIER.*

GENERALIZING from observations that are nearly always incomplete, botanists, in laying down the predominance in this or that region of certain families or genera, often conclude prematurely that they belong exclusively to the region in question. New facts, however, continually come before us which show that there is nothing absolute in the laws which have presided over the actual distribution of plants on the surface of the globe. Recently, for example, certain species have been discovered in Europe and in Asia Minor which are particularly interesting from the fact that their congenors inhabit regions far distant from each other. The first is a Dioscorea. The plants of this family are monocotyledonous and dioicous,† with stems usually, twisting, and climbing. Their root is a tuber, edible in some species under the name of "yams." The genus Dioscorea is very prevalent in the tropical regions of the old and new world; only a small number of species occurring in the northern temperate regions, among which may be mentioned the *D. villosa*, of the United States, and the *D. batatas*, of Japan, lately introduced as the Japanese yam. Up to this time no European species was known, though it was rumoured that M. Bubani, an Italian botanist, had found one in the Pyrenées.

I have just received specimens of the plant in question from M. Bordere, of Gèdre, in the Hautes Pyrenées, and from its tuber-shaped root, and its membranous three-celled capsules, it belongs, without doubt, to the genus Dioscorea. The *D. Pyrenaica* (Rub.) is an Alpine plant, which grows on cal-

* Translated from the *Archives des Sciences.*

† Having stamens and pistils on different plants.

careous debris on the southern slope of the Col da Gavarnie, and what is very remarkable, its stems not climbing, but dwarf and flexile, call to mind the stems of other species belonging to the Andes of Chili and Peru, and to the mountains of Mexico.

Another curious fact is the discovery, a few years ago, of a Pelargonium in the mountains of the East. The genus Pelargonium, which comprehends the species of Geranium, cultivated in our flower-beds, is characterized in the family to which it belongs by the nectiferous tube which descends from the calyx, and solders itself throughout its length to the peduncle. It has been regarded as exclusively indigenous to the southern hemisphere, most of its numerous species inhabiting the Cape of Good Hope, and some living in New Holland, while M. Kotschy has brought from Taurus, in Cilicia, a very fine plant, indubitably belonging to this genus. It has been found all along the same mountain chain from Pamphylia to Armenia. Like some other species from the Cape, the *Pelargonium Endlicherianum* has the lower petals very small, almost aborted, while the upper ones, very large, and of a fine purple, give the plant an ornamental character, and it is all the more valuable from its being able to stand our winters.

I pass to the third species which I have to mention. Some years since the botanist Bertero gathered in Chili a parasitical plant growing in great abundance on the branches of an Adesmia, a shrub belonging to the bean family. M. Guillemin found that it constituted a new genus, which he called Pilostyles. It has neither root, nor stem, nor leaves, and consists only of a bell-shaped flower two lines long, and sessile on the bark of the Adesmia, the epidermis of which it ruptures in its development. It is dioicous, and the male plant has not yet been found. The flower is surrounded at its base by seven bracts, and it is composed of a calyx of four oblong and imbricated parts, of a corolla of four spathulate* imbricated petals, a little larger than the calyx, and of a central column, thick, short, and obtuse, with its lower half attenuated, and surrounded towards the middle by a ring formed of three rows of unilocular anthers, upon which is another ring composed of closely approximated papillæ. This column is composed of cellular tissue, and a transverse section, examined under a microscope, exhibits the orifice of a very small number of isolated tracheæ. When the flowering is over, the blossom falls, leaving a depression in the bark of the Adesmia.

The singular production of flowers without a stem gave

* More or less rounded towards the summit, and narrowed towards the base." —Henslow's *Dict. Bot. Terms.*

rise at first to the strange notion that it was a monstrous growth of the flower of the shrub on which it was found, but this opinion could not be maintained when its structure was ascertained and its non-axillary insertion. It belongs to the family of the Rhizanths, or root-flowers, and is like a miniature of the gigantic Rafflesia, which is parasitical upon plants in the isles of the Eastern Archipelago.

The naturalist Pohl also brought from Brazil a second species of the same genus, growing on the branches of a Bauhinia; but for many years nothing new was added to the history of the Pilostyles, till this winter, examining a collection of dried plants from the Alpine and eastern regions of Asia Minor, made by M. Haussknecht, I found the branches of a spiny Astragalus covered at the base and round the points of insertion of the leaves, with little red globular bodies, that reminded me at once of the Chili plant. They were, in fact, Pilostyles, resembling in their chief characteristics *P. Berteri*, but specifically different from the absence of bracts, the shortness of the flower, and the number of parts in the calyx and corolla, which were five and six, not four. My friend, Dr. Müller, has made a detailed microscopical examination of this curious production, and he has found other differences. Thus in the eastern plant the ring of unilocular anthers round the central column is composed of two, and not three rows of anthers; the column itself (of the new plant) is shorter, and not contracted in its lower half. As is the case with the Pilostyles of Chili, the female plant is yet unknown in those of Asia Minor. Perhaps according to Dr. Müller, the zone of the papillæ, which surmount the outer ring in both species, represents a row of undeveloped ovules. If so, a certain analogy would be established with the Arums.

Thus we have an Oriental Alpine species, the *Pilostyles Haussknechtii* completing a genus only known to exist in South America, and of which all the species, which is remarkable, are parasitical on shrubs of the bean family.

It would be easy for me to enlarge the list of disjoined species—that is, of species growing in a botanical region, remote from the locality occupied by the rest of the genus of the family; but without wishing for little-known instances, there are some that astonish us less only because they are constantly in our sight. Is it not singular, for example, only to find one myrtle in the floras of Southern Europe, and only one laurel, while the rest of these numerous families inhabit the tropical and sub-tropical countries of two continents? If we reflect, however, that during the Tertiary epoch, myrtles and laurels were spread over Central Europe, we meet with an explanation, and are led, as has been so well shown by M.

Alp. de Candolle, in his *Geographical Botany*, to admit species of different degrees of antiquity, and to hope that an improved knowledge of the floras of geological epochs will enable us the better to understand the natural distribution of plants.

THE CLAMOR-ŒSTUS, OR TIDE-SHRIEK: A SELF-ACTING FOG WARNING FOR THE COAST.

BY H. TEMPLE HUMPHREYS, ASSOC. INST. C.E.

Among the treacherous sandbanks that are so numerous in our tidal seas, as well as on rocks and headlands of our coast, the want of regularly established fog-signals is a source of real danger to navigators of all countries who meet with these obstructions in the great channels of communication, or, worse still, as intricacies in the fair way of their entrance to important harbours. Take, for examples, the Goodwin Sands, the Shingles, off Ramsgate, the Verne and Ridge Shoals, not two fathoms deep, between Dover and Calais, the entrance to Cork Harbour, the Wolf Rock, the Acklow, Wicklow, and Blackwater Banks on the coast of Ireland, and many other localities which might be named, where the lighthouses and lightships already existing are altogether useless in foggy weather. Mists, which are common in the Channel Islands, and those which in Edinburgh are called "the Haáre," and which come with cold east winds from the German Ocean, render the navigation at those places, and at such times, wholly unsafe. An efficient self-acting system of coast warning by fog-signals would be a boon to ship-masters and pilots, by affording to them the necessary guidance in such embarrassing situations, as would undoubtedly save from destruction many a fine ship, bewildered in the pathless mists among the shoal waters subject to their visitation.

It is related that a passenger vessel, on its outward voyage to Australia, was once in imminent peril of collision with an iceberg, which, from its much lower temperature than the surrounding air, was, as usual in the case of those natural floating barriers, surrounded by a fog. The danger was in good time fortunately averted by the echo of the ship's whistle accidentally reverberated from the ice. On the Grand Banks of Newfoundland, where fogs constantly arising from the neighbourhood of the warm waters of the Gulf Stream brood over the surface of the sea, whistles of the kind in common use on railway engines, but much larger, are kept in constant play,

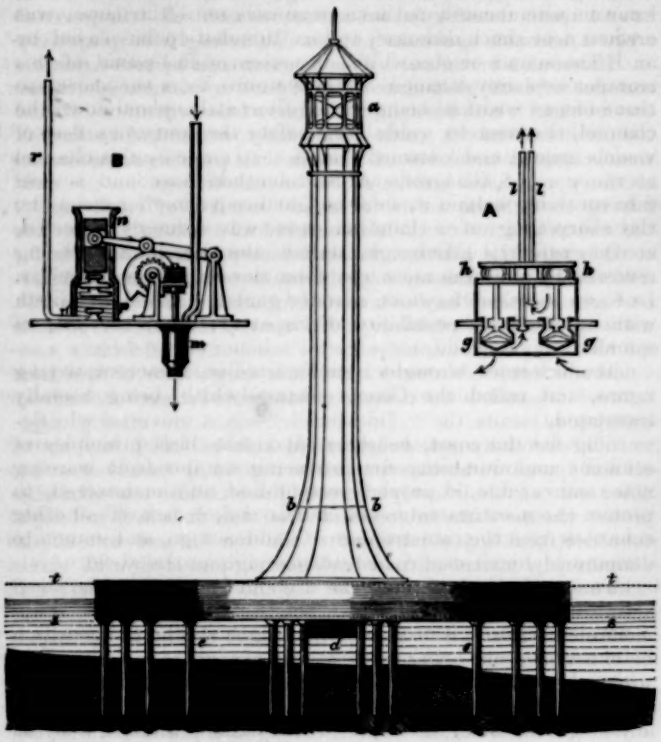
and answer admirably the purpose of warning the numerous fishing vessels off the shoals. In the channel between the adjacent islands of Bute and Cumbray, forming the narrow entrance to the Forth of Clyde, where fogs of more than ordinary density prevail, one vessel, at least, from this cause is known quite recently to have gone ashore. A trumpet was erected near the lighthouse, and is intended to be played by an Ericsson's air engine. The direction of the sound of this trumpet is plainly distinguishable five miles from the shore; so that in foggy weather, being turned alternately up and down the channel, it serves to guide with safety the numerous fleet of vessels inward and outward bound that enter by this channel at the port of Glasgow. A bell-mouthed horn and a steel disc revolving behind it, so as to produce a scraping noise like the sharpening of a hundred saws, was formerly directed, at Queensferry, Edinburgh, across the Forth, and being revolved by hand the noise could be thrown across the river. In foggy weather the boat, adroitly guided, crossed the Firth without the least possibility of departure from the line of sound.

The tower of wrought iron depicted in the accompanying figure, and called the Clamor-Œstus—which, being literally translated, means the "Tide-shriek"—is a universal whistle-warning for the coast, constructed on the best principles of economy and durability for producing an incessant warning note, and capable, if properly established and maintained, to protect the maritime interests of this and, in fact, of all other countries from the catastrophes of sudden fogs, so common to dangerously environed roadsteads throughout the world.

The mechanical effect of the rise and fall of the tidal swell acting in a certain given area, which in the figure is the basement of this tower, is less than what might at a first supposition be expected; but being most readily available in all situations where the Clamor-œstus would be used, and the contrivance of the Tide-shriek being to store up the accumulated effect for any length of time, the tower of the Clamor-œstus is truly an exhaustless water-power, in constant readiness for any emergency of haze, mist, or fog that may arise.

To understand the mechanism contained within the plates, angle-irons, rivets, etc., etc., which compose this tower and its base, it is only necessary to inspect the two accompanying sketches that closely adjoin the figure on either side. That on the left hand side represents all the apparatus necessary to produce the sound. It is placed upon the upper floor of the base, within the tower, and is called the hammer-whistle, whose parts will be presently explained. Above it the sides of the tower itself form a large water-tank, invisible in the

figure, used as a reservoir of water, and consequently of power, whereby the times of slack water, when there is neither a rise nor a fall in the tide, can be staved over; and by means of this provision the whistling note of warning can be constantly kept



Explanation of the Clamor-œstus, or Tide-shriek: a Syren or self-acting warning for the coasts in foggy weather.

a, Whistle; *b b*, bottom of water-tank; *c c*, tide-chamber, and level of mean tide; *d*, tide-way into tide-chamber; *e e*, screw piles; *f f*, sandbank; *s s*, *t t*, low tide and high tide levels.

A, section of tide-way and water-lift, enlarged; *g g*, inward and outward flow turbines; *h h*, force pumps; *l l*, ascending pipes. B, plan of hammer-lift; *m*, small turbine; *n*, hammer-block; *p*, air-chamber; *r*, whistle-pipe.

up, so that the repetition at regular isochronous intervals knows neither stoppage nor interruption, and the Tide-shriek is perpetually sounding day and night throughout the year.

The tower of the Clamor-œstus thus serves a double purpose; for while it supports the whistle at a height of about one hundred feet above the level of the sea, where the sound can better diffuse itself over the superficial stratum of the fog, it itself forms a capacious receptacle, in which a large amount of water power can be accumulated and kept in reserve until the time arrives when it becomes necessary to turn this extra power to account.

The sound of the whistle is concentrated by two reflecting surfaces of iron, shaped to their figure by a vertical ellipse, one focus of which occupies the place of the whistle itself, and the other traverses a circle round the tower at the distance of some miles at the level of the sea. In peculiar situations an ordinary parobolic reflector can be substituted in the loft, having the whistle at its focus, and capable of revolving by the directing force of the tide or wind to different parts of the coast, where the alarm, at stated intervals, is required to be directed; and in densely foggy weather two or more whistles of the same pitch can be sounded together in the whistle-loft, until the fog either lifts or drifts away; the power requisite for blowing the additional whistles being derived from a considerable head of water, which the large size of the tank makes it possible to keep constantly in store for such an emergency.

The sketch upon the right hand side of the figure shows all the apparatus necessary to raise the water from below into the tank. Placed in the bottom floor of the tower-base (a close circular chamber, one hundred feet in width and eight feet deep), it gives passage to the sea in and out of the chamber, by means of two turbines so provided with valves that one acts as an inward flow turbine and the other as an outward flow turbine. The whole tidal power of the sea within the area of the chamber, whether ebbing or flowing, is thus economised. The turbines, by means of a shaft, drive each a pump, the lifting power of which is of course proportioned to the driving force of the turbines. The whole gear is called the water-lift, and can be arranged, if preferred, with two hydraulic rams, the constantly repeated blows of which beneath the surface of the water would be audible for a very long distance.

The water raised by either of these means from the chamber or from the sea in the course of the tidal ebb and flow, is delivered into the upper tank by means of two ascending pipes, shown in the sketch. As the driving force of the turbines is about one-third of a horse power each, calculated for a basal diameter of one hundred feet, and a range of the lowest neap tides not less than six feet, in which the use of the Clamor-œstus would be possible, the constant work of the pumps is

ample to maintain a certain head of water (determined by a waste pipe) in the tank, and to afford besides a regular supply of water power to the remaining portions of the mechanism. A simple adaptation might possibly also utilize the power of the air, in entering and leaving the basement chamber, and thus decrease the size and cost of the apparatus. The chamber itself is erected perfectly horizontal at mean tide level, on two or more circles of screw piles, or upon some other solid and firm foundation according to the nature of the ground, and serves as the basement of the tower. Both tower and base are stayed and strutted within by lattice girders, diaphragms, gusset-plates, rivets, etc., so as to render them impregnable in the roughest assaults of a raging wind and sea.

A pipe leads down from the tank to another smaller turbine in the lower compartment of the tower. The turbine, which is shown in the sketch occupying the left hand side of the figure, is thus kept revolving constantly in one direction. The axle carries a worm pinion, that works in a toothed wheel driving a cam with uniform celerity, also in one direction. The cam raises a lever, and the hammer-block, weighing about one ton, is thus lifted—very much in the manner that tilt hammers are raised—and allowed to fall at each revolution of the cam, with greatly accumulated force, upon a piston in the air-chamber. Here the air and a spiral spring, that in its position of rest sustains the lever in its place at the top of the air-chamber, are suddenly compressed. Driven by the violence of the blow to escape by the ascending pipe shown in the sketch, the air rushes through the whistle with a shriek, which can easily be distinguished from other sounds heard at sea, and which, from its suddenness and intensity, it is imagined will be heard much further. The hammer-block is raised again and again, and falls at exactly such intervals as is determined by the speed of the turbine. The result of calculation on a base one hundred feet in diameter, with the least range of only six feet in the tide, is that a tower of the dimensions now contemplated would let fall one ton weight from a height of two feet at intervals of half a minute. The lowest range of the neap tides being taken as the basis of this calculation, the power can never be less, but may be considerably more.

Inasmuch as gratings, enclosing the whole of the gearing, would prevent seaweed gaining admission or egress, from impairing the effective action of the pumps and turbines, the Clamor-œstus, being entirely self-acting, would require no personal attendance beyond that required by an occasional inspection, but would go on working as long as the various parts hold together, and are not fouled by the growth of seaweed in the interior. The prime cost of its construction, on

an average, being also little more than a ninth part of the outlay in building the Skerryvore lighthouse (£86,978), or a sixth part of that expended upon the Bell Rock lighthouse (£60,000), and being moreover *the total cost* (it requiring no attendance), there are many points round our coast that would be admirably well served by such an apparatus as the Tide-shriek, particularly in places where a lighthouse, or a lightship would, from its great expense both in construction and maintenance, be inadmissible.

It is unnecessary to add, perhaps, that the tower of itself serves as an ordinary beacon, which is often erected without any lighting apparatus whatever, on dangerous shoals, rocks, etc.

THE PLANET SATURN.

(CONTINUED.)

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

We now proceed in our examination of the Saturnian system to the inner of the two bright rings.

II. Ring B.

1. *Dimensions.* Though inferior to the outer ring in compass, this has the advantage in point of breadth. Σ (1826) gave its exterior and interior diameters 34″·475 and 26″·668; De la Rue (1854) 33″·45; 26″·91; Jacob (1856) 34″·859; 26″·271. A mean of these (34″·261; 26″·616) makes its breadth 3″·822, which represents in round numbers* 16,000 miles, the widest known plane in the universe, and more than twice the diameter of the earth; so that its appearance gives us an idea of the diminutive aspect of our globe at a similar distance.†

2. *Reflective power.* This varies greatly in different parts. For a short distance from the outer edge it is highly luminous, much surpassing the brightness of A; usually equalling that of the equatorial zone upon the planet (Dawes, 1851, Oct. 26;

* An approximate estimate is preferred in this, as in the previous paper, to a precisely expressed value. It is desirable to give micrometrical measures in their completeness, to do justice to the observers; but the practice of deducing from them results in single miles, or sometimes hundreds of miles, can only mislead the inexperienced student, by conveying an impression of exactness which never has been attained, and is in fact not attainable.

† Not, however, the aspect of the earth from Saturn, which would be still more insignificant, as, when at mean distance, it would appear only half enlightened, and when circular, being further, would be seen still smaller, if the neighbourhood of the sun did not render it invisible.

Bond II., 1852, Oct. 28, Nov. 3; Coolidge, 1857, Jan. 30); and sometimes even exceeding it (Schwabe, 1841 to 1846; Coolidge, 1857, Mar. 16, 26). This, though probably changeable in extent and degree, seems to be on the whole a permanent characteristic; if, as is likely, it caused Hook, as far back as 1666, and Cassini, ten years later, and H in 1806, to consider the ring (taken as a whole) brighter than the globe;* the observation of the latter being made in connection with a remark which may be of practical value—that slight differences in brightness are well brought out by pushing magnifying power so far that light begins to fail. I thought the superior luminosity of the exterior part, with 3·7-inch aperture, more decided in Nov. 1853, than in subsequent seasons (1855-6-7, 1860). From the contrast thus produced, or possibly from a difference of structure, a peculiar distinctness has been remarked about its exterior outline; as far back as 1722, Hadley noted with his 5½-feet reflector that Ball's division was "stronger next the body, and fainter on the outer part"; and Secchi found, 1854, Nov. 19, that his power of 1000, while softening all the other lines, left this still of extraordinary sharpness. From this peculiarly luminous zone, which has no definite interior boundary, the light fades away across the breadth of the ring; but the degree and the circumstances of this fading are so uncertain that they properly fall under the next head; where also might be placed the singular irregularities of the outer edge, already mentioned in describing Ball's division.

3. *Subdivisions and Variations.* A heterogeneous composition is even more distinctly marked in this ring than in its neighbour, and the evidence of temporary alteration is at least equally strong. The first intimation of anything like a secondary division in any part of the ring-system was given by H in 1780. June 19 and 20, he saw with a 7-feet Newtonian, "a second black list," close to the inner *p* edge. 21 and 26, it was still visible in the same position, with a 20-feet reflector, even when reduced to 7-inch aperture; 29, though the belts were very clear, it had disappeared. It was nearer the inner edge of B, than the breadth of A, and his figures represent it ⅓ or ¼ of the width of Ball's division. This observation attracted much less attention than was its due, considering the want of symmetry and of permanency which were thus both at once, for the first time, made known in the structure of the ring, and which may possibly give us the chief aid to be expected—if any aid may be available—towards its real interpretation. After a long interval, during which it seems to

* The superior brightness of B, as compared with the globe, had been recognized by Hadley with his reflector in 1722.

have been nearly forgotten, the phenomenon turned up again, 1837, April 25, under the eye of Encke at Berlin. In viewing Saturn with a power of 400 in the 9·6-inch achromatic there, he not only rediscovered one of Short's divisions on ring A, but perceived for the first time a number of fine lines on the ansæ of B, parallel to its interior edge, and intersecting the whole breadth of the dusky shading (not real *shadow*) which, as will presently be described, overspreads the interior of this ring; and which Encke found most conspicuous on the W. ansa. May 20, however, though the division of A was clearly seen, these fine lines could not be made out. In consequence of this announcement, De-Vico at Rome, in the following year, turned the 6·3-inch Cauchoix achromatic upon Saturn, and saw, May 29, and occasionally for two months afterwards, not only the subdivision upon A, but two still narrower lines on B, of which usually that next the planet was most distinct when the other two were less defined. 1839, last week in May, the same. 1842, he stated that they had never been all visible at once on both ansæ. 1843, July 19 and Aug. 2, five divisions (including Ball's) were clearly seen. Sept. 7, when Dawes and Lassell observed Encke's division on A, they could find none on B. The next mention we meet with is by Bond II., 1850, Oct. 10, who was "almost, though not fully, satisfied" that there was a subdivision near the inner edge of B. Nov. 11, he was very confident of it. So again, 1851, Jan. 7, admitting, however, that it might be merely a dark spot or shading. Sept. 5, Tuttle (with the same instrument) saw it almost certainly, nearer the outer than inner edge. 1852, Feb., Bond II. saw it either as a division or dark shading, near inner edge, on many nights. 1855, Jan. 9, Coolidge perceived very plainly on the ansæ, three or four fine dark lines or divisions, close to inner edge. Inferior atmospheric conditions would of course obliterate these delicate details; but their intrinsic mutability may be inferred from such statements as the following: 1851, Sept. 15, Hartnup, with $8\frac{1}{2}$-inch in very fine air, examined the planet for three hours with powers up to 1100, but could detect no other than the primary division. Coolidge, 1855, Dec. 6, vision exceedingly good; powers up to 1243. 1857, Jan. 30, Mar. 4, very fine definition; no trace of divisions. Mar. 16, definition quite good; not the slightest trace. But besides these hair-lines, there is a general shading, extending from the neighbourhood of Ball's division down to, or nearly to, the inner edge, and usually increasing in depth as it approaches it; its dusky-red or brown tint, extending over at least $\frac{1}{4}$ B, was noted by Bond II., 1852, Nov. 3. Much latitude must be claimed for different apertures and judgments in fixing the extent of this shade, or, what is the

same thing, the breadth of the luminous zone into which it melts before reaching the outer rim; but with every allowance it seems variable in extent.* H in 1794, and Morton with Lord Wrottesley's 7¾-inch achromatic in 1857, commenced the fading about half-way. So Coolidge, 1857, Jan. 30; Bond II., Mar. 4; Lassell, Sept. 9, 10, 12. But Tuttle, 1851, Oct. 20; Coolidge, 1857, Feb. 12, 14; Mar. 4, 16; Lassell, 1858, April 17, gave the brighter zone but ⅓. Dawes, 1851, Oct. 26, ⅓; 1852, Sept. 25, ¼; while Nov. 29, Bond I. estimated it as narrow as 0″·5. It is also shown very narrow in the two designs of De la Rue, 1852, 1856.

A more curious fact, however, now comes before us. Though frequently overlooked by the best observers and under the best circumstances, as sometimes happens with sufficiently evident phenomena before attention has been called to them, yet there can be no doubt that this shade consists of a number of narrow concentric bands. This seems to have been first distinctly described by Tuttle and two others, 1851, October 20, the definition being admirable: though on this occasion the division on A was not seen with 141, and with that power those on B were like a dark spot, 851 drew them out like a series of waves—a number of narrow bright rings separated by equally narrow dark spaces, extending over ⅓ of B, and even, though less defined, very near to its outer edge. Whether the narrow dark streaks here described may be identical with the minute black lines of Encke and De-Vico may be problematical; the latter, however, is very careful (1841) to point out the difference between certain dusky belt-like traces upon B, and the extremely minute, black, and sharp subdivisions. They were also independently discovered about the same time by Dawes, who, after some previous suspicions, made them out clearly with 6·3-inches, October 26, arranged in a series of narrow concentric bands, extending about ¼ of the breadth of B; four could be distinctly recognized, each somewhat darker than the next exterior one, like steps leading down to the dark chasm within. He considered them probably separate rings, but too close for their divisions to be distinguishable. 1852, Sept. 25, he saw a streakiness again, and about this time Lassell found B shaded in rings like a number of infinitely fine divisions, or in terraces like an amphitheatre. 1854, Nov. 26, Dawes, with 7½-inches, observed that the duskiness was not continuously progressive; within the very bright outer zone was a narrow light shade, then a brighter stripe, then one considerably darker, and then a *much* darker one reaching

* The different estimates of its comparative brightness already mentioned, are more equivocal, since any variation might be as well ascribed to the equatorial belt on the globe, as to the zone on the ring.

nearly to the inner edge, where was a very narrow bright line. So again, Dec. 7, and 1855, Jan 10, with some doubt as to the uniformity of the second lighter band from the outside. This description nearly corresponds with De la Rue's drawing of Nov., 1852 (in the one of 1856 the shading is continuous). 1854, Nov. 19, Secchi found a similar appearance, distinguishing four bands at least, sometimes more; and he has recorded such abrupt shadings 1855, Dec. 15, 24; 1856, April 2, 25. 1856, March 20, Coolidge found four or five narrow divisions, giving the shaded part a wavy appearance. 1857, Feb. 12, the shading was not uniform, and more plainly seen *p* than *f*; 14, the same. March 26, shading not uniform, though without distinct waves. 1858, April 17, Lassell saw it in bands.

The mutability sufficiently indicated in some of these accounts is very clearly marked by the aspect of the inner edge. Kater, about 1826, received—no doubt from its faintness—the impression as of a rounding off of this part; and Σ I., when his measures were taken at Dorpat in that year, noted that this edge was not only pale, but less defined, whence he inferred that it might be less regular than the other. This comparative duskiness was also remarked by Bond II., 1850, Nov. 15, when he perceived in measuring that "it was difficult to decide where its inner edge terminated,"* though with better definition than ever previously, and power 401: by Secchi, 1855, Dec. 16, when he found a reddish and dusky tint in this part, not brightening at the edge; 1856, Feb. 4, when the interior boundary was "*difficile et évanouissant*," the bright border of Dawes he expressly states being not visible, though he saw the planet "*à merveille bien;*" and by Coolidge, 1857, March 4, who saw with very fine definition, under 688, the inner edge certainly not lighter. But at other times the contrary has been recorded. Thus, 1851, Oct. 26, Dawes found a brighter band at the bottom of his descending steps, making the very narrow and dark one next to it look almost like a division in the ring. 1852, Sept. 25, he caught this portion much brightened up, though in an extremely narrow line, with a dark distinct shading, like a sharply defined belt, outside of it; which latter he repeatedly distinguished again, 1855-6. 1852, Dec. 6, Lassell at Malta saw a bright line at this rim, plainer *p* than *f*. 1853, Dec. 15, Tuttle calls it perfectly defined, not worth transcribing for this expression, but for the curious addition that near the inner edge B has a reddish or copper-coloured tint, and has an appearance of mist or vapour. 1854, Nov. 26, Dawes describes a very narrow bright line, far less decided than in 1851 and 1852, which became broader

* This, it will be noticed, was the date of the recognition of the inner dark ring.

and less bright in 1855-6. 1855, Jan. 7, Secchi found this edge reddish, and separated from the rest of B by a dusky zone, of light slate-pencil tint. March 18, it was brighter. Dec. 24, rim a little brighter and well defined, as Lassell had found it three days before. And in each of De la Rue's engravings this edge is strongly marked by a very narrow white zone. To the above may be added, for the encouragement of the possessors of small apertures, that with 3·7-inches, 1853, Nov. 2 and 17, in ignorance of all the above except H's observation, I glimpsed a dusky mark on the *f* ansa, about $\frac{1}{4}$ of the breadth from the inside, which I believe was due to the brightening up of the edge within it. I traced it again, 1855, Jan. 27, Feb. 7, Nov. 14 (very certain); at other times it was difficult or doubtful. A still stronger proof of incidental change occurs in the curious observation of Schumacher, who noticed, some time after 1820, on five or six evenings, with a 6-feet achromatic, the inner edge sharp on the left or *p* side, but ill-defined on the other, with which Σ I., he says, concurred. 1854, Mar., with 7½-inches, and 1855-6, with 8-inches repeatedly, Dawes saw the same thing, the E. edge remarkably less distinct than W., and this was once independently noticed by another person.

We now leave ring B, to take in hand the most extraordinary part of this whole system, the

Dark Ring, C,

or gauze or crape veil, as it has been called—one of the most singular discoveries of modern times. Where it is projected as a dusky zone on the body of the planet it is, indeed, nothing new, and in all probability has been seen, under the mistaken guise of a belt,* from very ancient days. This is evident from many of the older figures. Cassini II. showed in 1715 that it was too little curved to be adherent to the ball; and Hadley also seems to have had some idea that it was not a belt on the globe, since it still attended the ring when the projection of this removed to other Saturnian latitudes, though, as he convinced himself, it was not real shadow. But the case is very different as to the interior of the ansæ, where nothing is behind it but the sky. How, on so dark a background, it could have so long escaped detection, it is truly difficult to conceive, excepting upon the supposition of an increase in its reflective power. It is not now an object of extreme or perplexing faintness, even in telescopes of but moderate size. It was seen distinctly (1853, Oct. 20) by several persons, and

* Or perhaps of a shadow cast by the bright ring, as mentioned by several of the early observers.

would have been discovered by one of them, who seems not to have previously known of its existence—with Mr. Burr's beautiful achromatic of only 3¾-inch aperture. It is sufficiently obvious with my 5·5-inch. When Hartnup turned upon it his 8½-inch he found it "could not be overlooked for an instant" (1851, Sept. 15). Where was it when ♅ fixed his 18 and 48-inch mirrors upon Saturn during so many years of a long life of observation? Where was it when Schr., at the end of the last century, in particularly examining this region, to ascertain whether the ring was actually disconnected from the globe, found with 19 inches of reflecting surface that the interior of the ansæ was almost always, whether by night or day, or moonlight, slightly darker than the surrounding sky,* and without any trace of interior light? Where was it when Σ I. scrutinized and measured the whole system so repeatedly and carefully with the Dorpat 9·6-inch achromatic as late as 1826, and noted the indistinctness of the inner edge of B—caused, no doubt, by its unrecognized presence? Where was it when, in 1830, H. got that view of Saturn in his 20-feet reflector, mentioned in our last number, such as he never again expected to obtain? To these questions we can give no answer.

Before this latter date, however, it had been actually seen at the Roman observatory: at least, so Secchi was told by an old assistant there, who remarked that it had been noticed after they mounted the 6·3 Cauchoix achromatic in 1828, "*sans toutefois en discuter ou relever la nature et la constitution physique.*" There is little difficulty in admitting testimony so endorsed, but very great, in conceiving the state of mind which treated such a sight with unconcern. They did not deserve the credit of the discovery, which is justly awarded to Galle at Berlin, at least as far as the filling-in of the dark ansæ is concerned. This he noticed, 1838, May and June, and again 1839, observing that the inner edge of B was ill-defined, and continued on towards the ball for some distance; but he seems not to have detected its connection with the dark shade across the ball. His announcement, strange to say, attracted little or no attention on the continent,† and was elsewhere unknown; and the planet subsequently went far S., which made such

* That this peculiarity—the result, we must suppose, of contrast—was not due to any fanciful bias in the mind of Schröter is evident from the American observations; the same thing having been noted, 1856, March 17, by Coolidge and Bond II., and again by the latter, March 31, April 7.

† Beer and Mädler, though they had been observing Saturn regularly at Berlin, do not even allude to it in their "Beiträge," pub. 1841. Its projection upon the globe is there called a grey belt, so similar in colour to the shading or the interior of B, as to lead to the idea that each may be a collection of some kind of fluid; two perpetual flood-tides, one round the equator of the ball, the other round the inner edge of the ring. They could detect *no other belt*; Mr. Grover has seen them repeatedly, and well, with only two inches.

observations more difficult, and they were not renewed till 1850, Oct. 10, when Bond recorded that inside of B there was a feeble illumination before noticed, but not accounted for; 11, it was better made out; 15, Tuttle suggested the idea, which commended itself at once, of an interior dusky ring. Nov. 25, before this news had been received in England, Dawes made the same discovery, perceiving on the spot its true character; and it has since been always seen with sufficient apertures in favourable air.

1. *Dimensions.* Galle measured it, 1839, (6 nights), 2″·125. Dawes, 1850-51 (mean of 22 measures), 1″·941. Σ II., 1851, 2″·035. Hence its breadth comes out about 8500 miles, more than the diameter of the earth. Some differences in its apparent extent will be subsequently mentioned; and the question of its thickness will recur hereafter.

2. *Partial Transparency.* This very curious fact was discovered independently in various quarters about the same time, in the autumn of 1852. Sept. 22, Jacob speaks of seeing the planet through it as through a film of smoke. Sept. 25, Dawes first inferred it from the want of blackness in its shadow on the ball, which was not distinguishable, except as making the whole projection appear too broad; afterwards he detected the globe through it. About a month subsequently, Lassell traced the limbs readily through it, and De la Rue drew it so about that date. Other observers were considerably later; but it is just the kind of thing that might not be seen till it was looked for. In estimating the degree of transparency, the valuable remark of Dawes must be remembered, that we see the ball by light which has passed through the ring twice, and has suffered double loss. But whatever may be the amount of light by which the ring is seen, there is evidence that it is not phosphorescent but reflected, in the fact that it is invisible where it lies in the shadow of the ball, as seems to have been first noticed by De la Rue, 1851, Aug. 13.

3. *Colour.* Its real tint is only shown upon the black background of the sky, where it is generally described as of a slaty hue (Hind, undoubtedly light purple, 1853, Jan. 9). Where its own light is intermingled with that of the ball seen through it, its tint is of course not merely lighter but compound; here it is generally spoken of as a dusky grey.

4. *Subdivisions*, and *Variations* of different kinds. The appositeness of Dawes's remark, that if, as he thought likely from its situation and small reflective power (its transparency had not then been noticed), it was of a fluid nature, its conditions might be very variable, and it might be subject to changeable divisions, will be found very evident. It is not even certain whether it is permanently separated from the adjacent bright

ring. The effect of strong contrast no doubt makes the observations difficult, and there is little uniformity in the record of them. 1850, Nov. 15, Tuttle, at its first discovery *as a ring*, saw inside (?) of C very sharp, but not detached from B; a rather unintelligible description (repeated, however in substance by Bond I., 1852, Nov. 29, and Coolidge, 1855, Dec. 6). Dec. 3, Lassell with Dawes's telescope saw a dark ill-defined boundary: Dawes saw it also this season. 1851, autumn, Σ II. perceived not the slightest trace of division, nor Secchi, Sept. 2. Dawes, Sept. 11, Oct. 26, saw a distinct black line; again 1852, Sept. 20. Sept. 25, a division, rarely visible, of not half 0″·3 as he at first thought. 1853, Oct 24, an exceedingly narrow line at times. Dec. 15, Bond II., no interval. 1854, Secchi, ditto. 1855, Jan. 5, Feb. 21, division well seen. Nov. 15, Dawes, *p*, only. Dec. 16, Secchi, about ½ width of Ball's, but possibly from contrast. 24, about ⅔ Ball's. 1856, Feb. 4, very marked; 9, ditto, about equal to Ball's, broadest *f*. 1857. Mar. 4, 16, 26, Coolidge, no trace of separation.

Another variation. During the autumn of 1851 a black division was certainly and easily seen upon each ansa of C, and its situation measured, by Σ II. In the winter of 1852 he could not find it. De la Rue had not seen it, 1851, Aug. 13, nor Lassell, Sept. 9, 10, 12. 1852, Oct., Jacob speaks of a suspicion of a sort of scalloping on the ansæ of C, like the fold of a curtain. 1853, Jan. 9, Hind; 1857, Feb. 12, Coolidge, found no division.—Again. In the winter of 1850, Dawes perceived, by means of observations in the progressively fading twilight, that C consisted of two zones of unequal visibility and breadth, divided by an extremely narrow line, the exterior and brighter part occupying ⅓, the two together ½, of the distance from B to the ball; and this, excepting the narrow division, he confirmed in the autumn of 1851.—1852, Oct., Lassell, during an exquisite view at Malta, could not catch a glimpse of Σ II.'s division, or Dawes's zones; the surface being quite uniform; and so again, in a very fine view, 1858, April 17, and Secchi, 1854, Nov. A degradation of brightness inwards has, however, been noticed at other times, not only by Dawes, 1853, Oct. 24, Nov. 2, and 1855; but Hartnup, 1851, Sept. 15; Hind, 1853, Jan. 9; Secchi, 1856, Feb. 9, certainty being given in the latter case by the favouring presence of twilight; C being visible in the Roman sky with 9½-inches just after sunset!* On the contrary, 1851, Sept. 5, Bond I. saw it less bright next to B (contrast?).

* Thus on the night of its first discovery as a ring by Tuttle (1850, Nov. 15), it was seen through thin clouds, only 8° or 10° from the moon; and in a similar way Lassell found the contrast of brightness far more striking between A and B *before sunset*. Such is the working of large apertures.

Remarkable anomalies in breadth are also well established. The general proportion assigned to it in both worlds from the first discovery* has been a little more or less than half the width of the opening. Hartnup, 1851, Sept. 15, gave it full $\frac{1}{2}$, or $\frac{1}{2}$ to $\frac{3}{5}$. Fletcher, Nov. 12, $\frac{1}{3}$; but this was doubtless merely Dawes's brighter zone. Lassell, 1852, autumn, certainly more than $\frac{1}{3}$, barely $\frac{6}{10}$. Hind, 1853, Jan. 9, $\frac{2}{5}$. Secchi, 1854, Jan. 6, as four to three, or three to two. Weather and vision might influence all this, and any observation relating to the whole ring at once. Yet it looks suspicious when Coolidge tells us, 1857, Feb. 12, that having always previously seen it not quite $\frac{1}{2}$, he found it fully $\frac{1}{2}$ or more; 14, fully $\frac{1}{2}$, but on one side only; Mar. 4, 16, not quite $\frac{1}{2}$. But stronger cases follow, implicating breadth with density, which possibly affects the extent of its partial, or even general, visibility. 1850, winter, Secchi always found it "*plus nette et plus claire*," *p*. 1854, Hippisley's 9¼-inch mirror showed it more transparent *p* than *f*. 1856, Mar. 27, Coolidge found it darker than usual across the ball. April 1, with unequalled definition, darker *f* than *p*. 1857, Feb. 12 (the first night when an increased breadth was noticed), much easier seen *f* than *p*, where it was quite difficult of definition from its darkness. Yet its tint was uniform across the globe, and its inner edge was sharp. It is worthy of remark that no observer has ever hinted at any defect in this respect, as though it might extend itself imperceptibly towards the ball. Assertions to the contrary are frequent in all quarters, and Coolidge even speaks of it, 1855, Dec. 6, as sharp with a power of 1243! Feb. 14, much plainer *f* than *p*, where it was quite dark; but colour uniform; edges sharp, and transparency great. Mar. 4, equally seen on both sides, quite sharp against sky, but less defined on globe; less than $\frac{1}{2}$ broad. 16, quite light across ball, and darker than last year on sky; possibly from atmosphere [more probably, increased transparency ?]. 26, at least as bright and distinct *p* as *f*. Schwabe, who had watched it from 1851 to 1857, with a 6-foot achromatic, and considered it brighter in the centre than at either edge, thought it scarcely ever of equable light, but composed of brighter and fainter parts, of irregular breadth, and as if formed of cloudy condensations; commonly, but not invariably, broader and more distinct *p*. Σ II., 1857 (1856 ?)† states that its breadth that spring was double, or at least 1·6, *f*. "This feature was so striking on Mar. 20 that it could be seen even by unpractised observers on the first glance." 1858, winter, Noble saw it especially bright

* The impression that it was seen very narrow at first in America arose from a bad engraving.

† For the cause of this ambiguity, see *Monthly Notices*, Vol. xvii. No. 6.

p.* 1863, Mar. 26, Carpenter perceived the dark space much contracted in the Greenwich transit-circle, and, with the large equatoreal, found a great increase in the brightness of C, which appeared "nearly as bright as the illuminated ring, and might easily have been mistaken for a part of it." Under this head we may include two observations, possibly indicating unusual transparency; by Jacob, 1852, Sept. 22, when it was umber-brown on the ball, though slaty off it; and Bond II., 1856, Feb. 28, who found the planet seen through it yellowish or orange. And although its tint is generally described as quite uniform, especially by De la Rue, 1851, Aug. 13, and Secchi, 1854, Nov., yet it was seen mottled by Hartnup, 1851, Sept. 15, and Lassell, 1853, Jan. 12.

But there is another strong and curious proof of instability, in its change of hue. This may sometimes affect the whole ring, for Dawes describes it as rather brown, 1853, Oct. 24, and Secchi, 1855, Dec. 5, 24, reddish, though at other times decidedly bluish, and 27, more blue than usual. But observations are more frequent of partial contrast in the two ansæ. This was first recorded by Secchi, 1851, Sept. 2, when it was ruddy and more distinct *p*, bluish *f*. Oct. 26, do. *f*. being the broader. Lassell perceived it independently and with certainty, and detected its alternation, 1852, when Dec. 28, and 1853, Jan. 6, 25, *p* was bluish grey, *f* brown; Jan. 12, 28, Feb. 3, the same tints reversed. 1853, Oct. 25, Dawes saw *p* the browner, and though Secchi expressly noted an uniform tint, 1854, Jan. 7, and Dawes, Sept. 26, yet Dec. 26, the latter saw *f* ruddier than *p*, and 1855, Jan. 10, rather ruddy *p*, slate-coloured *f*. Nov. 27, Lassell found *p* brown, *f* grey. 1856, Jan. 11, Secchi, blue *f*, reddish *p*, with a special change of achromatic eye-pieces.†

We have now given the details of each zone in succession. Some facts, however, remain, which relate more properly to the ring as a combined system. One is its dimension as to thickness. This was long ago perceived to be exceedingly minute; astonishingly so, as compared with its outspread diameter. The plane of the ring, like that of the terrestrial equator, being at once considerably inclined to that of the orbit, and nearly parallel to itself in all positions,‡ it must, in the course of its revolution of rather more than twenty-nine and

* (*Addendum* to our last No.) The division on ring A was glimpsed by this observer with 4·2-inches, 1858, Jan. 13, 14.

† The only observation of the kind in America (1857, Feb. 14) was due to a defective eye-piece. But such a cause is very easy of detection, and would have been as readily perceived at other observatories, if it had existed.

‡ The plane of the ring, like that of our equator, is subject to slight perturbations from external influence; but these are of no importance in our present view of the subject.

a half years, twice pass through the sun, as the plane of the earth's equator does at the time of our equinoxes. At these epochs its edge alone receives the solar light, and we can therefore form some estimate of its thickness. As, however, our point of observation is not in the sun, and the plane of our orbit does not coincide with that of the orbit of Saturn, appearances to us will be somewhat varied. If the earth, at the time of this lateral presentation of the ring, should be in, or very near, the plane of Saturn's orbit, we see the ring almost exactly as we should from the sun. This does not often happen; but our disadvantage in this respect is more than compensated by the fact that the obliquity of our orbital motion exhibits to us the illuminated edge of the ring alone in positions where, had we been in the sun, we should have seen a considerably greater breadth of it. For there are three ways in which we may see nothing but the edge; either, 1, because the ring-plane passes through the sun, when the edge alone is illuminated, and therefore, whether we are situated above, in, or below that plane, we see the edge alone; or, 2, because that plane passes through the earth, when, wherever the sun may be situated, we look upon nothing but the edge; or, 3, because that plane passes between the sun and earth, when the enlightened side is turned from us, and though we see a certain breadth of the ring, yet, excepting across the ball, where we notice a black line, the edge is the only visible, because the only illuminated part. In any one of these cases our telescopes ought to give us information of the thickness of the ring; but so marvellously slight is that extraordinary system that the testimony is negative rather than positive. It has been stated that H never lost sight of the ring; but his expressions do not necessarily infer uninterrupted continuity. Schröter lost it entirely with his 19-in. speculum, 1803; H with 18-in., 1833; Dawes with Lassell's 24-in., 1849. Granted that atmospheric circumstances must render such delicate observations very precarious, there is still a limit to this uncertainty, and we readily perceive the extreme character of the attenuation. The American observers distinguished themselves by their especial attention to this point in 1848. They were well provided for the research, having the command of an achromatic by Merz with a focal length of 22·5-ft., and an aperture of 14·95-in., the whole of which was employed. Its optical perfection was such that on rare occasions the discs of the satellites of Jupiter were well shown with a (nominal?) power of 2000, and double stars, 0″·3 apart, were separated with 700 and 800; the fifth star in the trapezium of Orion was visible after sunrise, and the sixth separated, with 141, from its bright neighbour. The result was a very interesting one.

The exact passage of the ring-plane through the sun could not be observed, as it happened about noon, September 3, but only fourteen hours afterwards it was surprisingly bright, as though, after its winter's night of fifteen years, it had been covered with snow. The first passage through the earth, between September 12 and 13, took place during a time of bad definition, and the doubt of its visibility on the latter night is of no great weight. When looked for a few hours after the second, 1849, January 19, it had already acquired a sensible breadth. But there were two long observing periods from 1848, June 25 to September 3, and from September 13 to 1849, January 19, during which, as we looked on the dark side, it might be presumed that we should see, through part of its length, only the illumination of the outer edge; and the general result of forty nights' observations was that the thin line of light was never wholly lost except in bad weather, and with the best definition was occasionally continuous, though not equable, in its whole extent; and from some calculations dependent upon the proportion of the apparent brightness of the ring, according as its enlightened or unenlightened side was turned towards us, they considered it probable that its thickness was less than 0″·01, under forty miles! It must, indeed, be admitted that this value depends upon a precarious condition—the adequacy of an eye-estimate of the proportion of brightness, and upon the assumption that the edge is equally reflective with the rest of the ring. But, these being granted, there is no room to question the conclusion. If we adopt Bessel's determination of the mass of the ring ($=\frac{1}{1\,1\,7}$)*, a density of material would follow three times greater than that of the ball; and as this would increase with any further diminution of thickness, the American observers conclude that it is probably not thinner than this limit. It may be easily shown, at any rate, that no fallacy is involved in the idea of extreme attenuation. The disappearance in the great reflectors of H. and Schr. would alone have proved this, but it follows equally from Bond's observations, in which it evidently reached the *minimum visibile:* for instance, 1848, October 6, "under admirable definition," though the edge of the ring was well seen throughout, it inclined to "a beaded and broken appearance," especially *f;* October 7, definition exceedingly fine; its light appears broken, especially *f*. Nov. 22, never so well seen before; a space where the light is intercepted on each side (Bond I.); continuity not certain (Bond II.)†. The idea of less reflective

* Jacob, however, thought it insensible in his own observations.

† The ring was never entirely lost in May, 1862, with the great equatoreal at Greenwich, but the light was interrupted and deficient; and the same seems to have been the case (though the record is not quite clear) with the still larger instrument at Poulkowa.

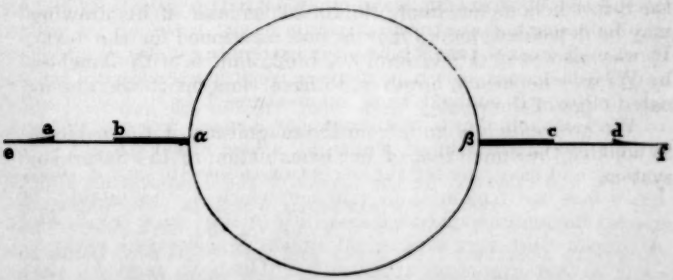
portions on the edge being in this last case excluded by the symmetrical appearance, it is evident from perspective that the narrowest presentation is the real thickness. Now it appears, from the observations of Jacob and Secchi on the subdivisions of ring A (see our last number, pp. 260, 261), that a dark line $\frac{1}{8}''$ or $\frac{1}{10}''$ broad could be distinctly seen with their smaller means, and from irradiation a bright line of the same degree of visibility would be of much smaller real dimensions still, so that even by this rough way of estimation we should possibly arrive at a thickness of $\frac{1}{20}''$ or $\frac{1}{30}''$, or 150 to 200 miles. H., from the entire disappearance, in 1833, in a reflector which must have shown a bright line of $\frac{1}{40}''$ deduced a *maximum* of 250 miles. This gives a ratio of $\frac{1}{676}$* to the diameter, Bond's being $\frac{1}{4000}$. Since the paper on which these remarks are printed may be taken to have a thickness of about $\frac{1}{4000}$ inch, it would require, on H.'s supposition, a circle cut from it of $3\frac{1}{3}$ inches—on Bond's, one of 21 inches in diameter—to represent, in a very general way, the limits between which the proportional thickness of this astonishing zone must be comprised!

A phenomenon already alluded to requires further elucidation in this place. When the ring is thus viewed edgeways it is not found of apparently uniform thickness; and the more prominent beads or globules of light, of which there are generally two on each side, occupy permanent positions. This appearance was referred by Schr., in 1802, to the existence of mountains on the ring, especially on its S. surface, 100 miles in height, from the unchanged position of which he inferred the non-rotation of the ring. Olbers, however, explained it, to the satisfaction at least of Harding, Schr.'s assistant, by the perspective of an unequally illuminated circular surface, inclined gradually less and less to the direction of vision; for as it is foreshortened down to invisibility, the extremities of the brightest zones will acquire a great increase of proportionate intensity where they are doubled back upon themselves, and from the irradiation common to all luminous objects, will appear enlarged and continue longest in sight. This would account in a natural and easy way for the aspect of the disappearing ring; but it fails to explain the existence, which is indubitable, of similar inequalities when we look only on the dark side. The American observers took great and very successful pains to clear up this mysterious appearance. On eight nights in 1848 they measured the position of some or more of these brighter portions, and the result was a deviation so slight, averaging less than $0''{\cdot}2$, as to prove their symmetrical arrangement; while the singularly exact accordance of their distances from Saturn with the micrometric dimension of the rings, showed

* If, with H. we adopt ⅄ L.'s value of ring A, the ratio will be $\frac{1}{753}$.

beyond a doubt their real origin; they were due to additional light reflected at those spots, by the concurrence of the outer and inner edges of ring B with the faint line representing the exterior rim of A. The following designs are copied from their most valuable memoir; but I have taken the liberty of omitting ring C, both from the diagram and its explanation, through

an impression that so unreflective a material could hardly be influential enough in the final result to justify the additional complication. It must be borne in mind that this design is an intentional exaggeration for clearness' sake, representing the dark surface much more expanded than it ever really is, and the thickness of the rings many (they say perhaps 10) times too great. To this they add the qualification that the edges should be rounded; and I should be inclined to suggest another, that A may probably be much thinner than B, so that its inner edge would add little to the effect. Comparing then, this with the following diagram, we should have, 1. a narrow dark band



upon the planet, slightly curving upwards, and consisting of both the dark side of the ring and its shadow (the latter not inserted in the first diagram); 2. the outer edge of A visible throughout, but with extreme difficulty when alone, as between a and b, and c and d, and towards e and f. 3. Two brighter portions from a to b, and from β to *c*, where the light of A is

reinforced by that reflected by the inner edge of B. 4. Two bright knots where the same light, strengthened by the concurrent reflection from the inner edge of A and the outer of B [the latter, it may be presumed, many times outweighing the former], reaches us through the opening of Ball's division. This the Americans considered fully satisfactory; the curvature of the black stripe having been noticed, and estimated at 0″·25; the extremities of the line, and the beads, falling beneath its direction, as from the diagram they ought to do, and the accordance of measures fully bearing out the impression of Nov. 3, that the "interruptions in the light of the ring are so plainly seen, that no one could for a moment hesitate as to their explanation." It was suggested by Dawes, at the time of the discovery of ring C, that B might possibly be thicker at the inner edge, which would fully accord with this idea. Those who think that the darker colouring of parts of B, as well as of A, may arise from greater thinness and consequent partial transparency, may still suppose that the back of the exterior and denser part of B, beyond the ball, is the reflective portion. It seems singular, however, that C, whose projection upon the ball is so obscure, should not interfere more with this reflection, and that if, as Jacob supposes, Ball's division is filled by a similar material, the external edge of B, viewed through it, should form so strong a knot of light. The American observers make no mention of the division of the dark stripe upon the globe into two by a narrow bright line, indicating the distinction of the dark side of the ring from its shadow. This most delicate object was, however, seen in the use of much smaller optical means during the same season, by Dawes with 6¼-inches, Oct. 26, 30, Nov. 21, and by Schmidt at Bonn with the 8-feet heliometer, Sept. 19, 20, 21 (at least, if his drawing may be depended upon, for it is not mentioned in the text). It was also seen 1861, Dec. 26, 1862, Jan. 5, with 7-inches, by Wray, who seems, however, to have thought it the illuminated edge of the ring.

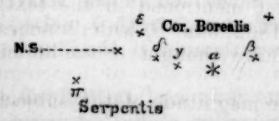
We are again obliged, from the magnitude of the subject, to adjourn the conclusion of our examination of the Saturnian system.

THE "NEW STAR"—MR. HUGGINS' INVESTIGATIONS.

THE appearance of a "new star" in the heavens is, notwithstanding many recorded instances of such incidents, a phenomenon of a very startling and suggestive kind; and though the star that has very recently made a conspicuous appearance in the Northern Crown (Coronæ Borealis) has not that splendour which earlier visitants of the same sort have frequently displayed, it possesses the unique and extraordinary interest of being the first of these bodies subjected to spectroscope examination, and yielding unlooked for and marvellous results.

On the 16th of May, Mr. William Huggins received a note from Mr. John Birmingham, of Tuam, stating that on the 12th of May he had seen a second magnitude star near ϵ Coronæ. The next post brought Mr. Huggins a letter from Mr. Baxendell, of Manchester, repeating the information that a new bright star had been seen about a degree south of ϵ Coronæ. On the evening of the 15th, Mr. Baxendell found it to be of the third magnitude, fully equal to β Serpentis and ν Herculis, both third magnitude stars.

On the night of the 16th of May, Mr. Huggins examined the spectrum of the star, and he informs us, "That it was below the third magnitude, but brighter than ϵ Coronæ Borealis. The spectrum is extremely remarkable, unlike that of any celestial object I have observed. There is an absorption spectrum analogous to that of the sun, and in addition a spectrum of a few bright lines. Two of the brightest of these appear to be coincident with those of hydrogen, and correspond in position with F and C of the solar spectrum."



On the 17th of May, Mr. Huggins again observed the star, and found it about the fifth magnitude, and not so bright as ϵ Coronæ Borealis, which is marked four and a half magnitude. The accompanying diagram will assist our readers in finding it, if it remains of sufficient magnitude.

Mr. Huggins promptly communicated his very important spectroscopic investigation of this star to the Royal Society, in a paper read on the 17th, and his results occasioned the strongest interest in scientific circles. It is impossible to avoid forming hypotheses in connection with so curious a subject as the sudden appearance of a new star, whether, indeed, we regard such a body as new in any of the three senses in which that term may be employed, that is, as newly formed, newly occu-

pying the place in which it is discovered, or newly assuming sufficient brightness to become visible.

Humboldt, in *Cosmos*, gave the following list of newly-appeared temporary stars, though "with variable degrees of certainty" as to the items:—

134 B.C., in Scorpio.
123 A.D., in Ophiuchus.
173, in Centaurus.
369, in ?
386, in Sagittarius.
389, in Aquila.
393, in Scorpio.
827, in Scorpio.
945, between Cepheus and Cassiopeia.
1012, in Aries.
1203, in Scorpio.
1230, in Ophiuchus.
1264, between Cepheus and Cassiopeia.
1572, in Cassiopeia.
1578, ——
1584, in Scorpio.
1600, in Cygnus.
1604, in Ophiuchus.
1609, ——
1670, in Vulpes.
1848, in Ophiuchus.

Humboldt remarks that "the stars whose luminosity was of the shortest duration were those of 389, 827, and 1012. In the first of the above-mentioned years the luminosity continued for only three weeks; in the second, four months; and in the third, three. On the other hand, Tycho Brahe's star in Cassiopeia (1572) continued to shine for seventeen months, while Kepler's star in Cygnus (1600) was visible fully twenty-one years before it totally disappeared. It was seen again in 1655, and still of the third magnitude, as at its first appearance, and dwindled down to the sixth magnitude, without, however, according Argelander's observation, being entitled to rank among periodically variable stars."

Herrmann Goldschmidt considers the new stars of 393, 827, 1203, and 1609 are one and the same; and *Monthly Notices* for April contains a paper on this subject, with his reasons for expecting its probable re-appearance from 2014 to 2015. M. H. Goldschmidt says, with reference to the irregularity thus imputed to this star, that he has "observed *u* Geminarum (Hind, No. 6) coming exceptionally back twenty-four days before its ordinary return, and this with a period of ninety-six days. Goodricke had previously suspected the identity of the stars of 945, 1264, and 1572.

It will probably be found that the star now occupying attention is not really a new visitor, but a small one that suddenly increased in lustre through violent internal chemical changes;* a sudden blazing up in conflagration-fashion of an

* Since writing the above Mr. Knott informs us that it is entered as No. 2765 zone + 26° in Argelander's *Bonner Sternverzeichniss*, epoch 1855·0; mag. 9·5; R.A. 15h. 53m. 26·9s.; D + 26° 20'·1.

immense mass of gaseous matter, and its equally rapid subsidence. This is a probable inference from the information afforded by the spectroscope, and it will supply material for theories as startling as the phenomena which suggest them.

There does not seem to be sufficient evidence for considering that the Corona star differs in telescopic appearance from other stars. Mr. Knott, who is an excellent observer, and who, in addition to the advantage of a very fine telescope (7½-inches aperture), has a remarkably well situated observatory, informs us that he first examined it on the night of the 17th, "when its colour appeared to be of a fine pale yellow—pale as compared with the golden yellow of ϵ Coronæ." On the 18th the colour appeared the same, and so on the 19th, when its magnitude had decreased, so that it was "decidedly less than δ Coronæ." On the 20th Mr. Knott gauged its magnitude as 6·4, and having heard of Mr. Huggins' spectroscopic discovery, he looked carefully for any peculiarity in its light. It still appeared pale yellow, and he could detect no trace of a nebulous envelope. He thought it a little dull. On the 23rd he found its magnitude 7·2, its light rather unsteady, and its colour a very pale yellow, with perhaps a greenish cast.

The history of temporary stars shows that the majority of these curious bodies have usually evinced great splendour at the time when they were first seen. Humboldt says that only three of the known stars of this kind have been less than the first magnitude, which was the case with the star now visible. The star of 125 B.C. was visible in the day-time, and is "said to have attracted the attention of Hipparchus;"* that of 389 A.D. was for three weeks as bright as Venus, and then disappeared entirely. The stars of 945, 1264, and 1572 were brilliant bodies; and that in 1572 so bright that Tycho Brahe had his attention called to it by seeing, as he was walking home, a group of rustics staring at it in a position which he was sure it had not occupied an hour before. At this time it was as bright as Sirius, and reached the lustre of Jupiter, and was seen at midday. It was first seen on November 11, in December it diminished, and disappeared in the following March. In October, 1604, a star of similar splendour burst forth in Serpentarius, and was visible till October in the following year.

Humboldt remarks that, in the three centuries from 1500 to 1800, as many as forty-two comets visible to the naked eye appeared to the inhabitants of the northern hemisphere, while only eight new stars were observed during the same period. Taking the time from the completion of the Alphonsine tables to the days of Sir W. Herschel—that is, from 1252 to 1800—he tells us "the number of *visible* comets was sixty-three, while that of new stars does not amount to more than nine."

* Sir J. Herschel's *Astronomy*.

In the case of Tycho Brahe's star, we are told by him that it was "not surrounded by any nebula, and was perfectly like all other fixed stars, with the exception that it scintillated more strongly than stars of the first magnitude."*

Before the appearance of this last so-called "new star" and Mr. Huggins' spectroscope investigation, it was considered that these bodies could not be ranked in the same category with the variable stars, even though it might be admitted that some of them had re-appeared on successive occasions. They may form a class by themselves, but the very small number that is likely to be seen in any period of a few centuries precludes the hope of the present generation of astronomers being furnished with means of answering such an inquiry.

Among the numerous speculations that may be entertained, one is, that these stars represent a particular stage in stellar life and formation; and if the ordinary orbs of heaven exhibit such permanence as to be poetical symbols of unchangeableness, that fixity of character may be the result of previous conditions, in which violent fluctuations and agitations occurred. If the "new stars" were regarded as new formations, or stars in any process of growth, we might expect to find a corresponding number of celestial bodies suffering diminution and decay. Humboldt, who searched for evidence on this subject, considered that great caution was necessary before coming to the conclusion that any star has actually disappeared. He threw out the hint that "dark cosmical bodies may, by a renewed process of light, again become luminous."

The amount of stellar light received by us might vary from (1) change of distance, (2) the interposition of planetary or other bodies, or (3) from actual fluctuations in the intensity of chemical actions in the star or its atmosphere. The two last are the most likely means of accounting for considerable changes in lustre occurring in brief periods; and while the second may apparently fit the case of ordinary variables, the third would seem better able to account for the remarkable phenomena of the so-called temporary stars.

It does not appear that the distance of any temporary star from the earth has been ascertained; but if any new one should last for sufficient time, the perfection of modern instrumental research will, no doubt, be directed to that end. Waiting for further facts on this highly-curious subject, we may give free rein to speculation, provided only that we know we are speculating, and do not confound the day-dreams of science, which may prefigure truth, or suggest error, with those opinions that rest upon wide inductions, and which we may more certainly receive.

* Tycho's statement is quoted in *Cosmos*.

ON THE VELOCITY OF NERVOUS IMPRESSIONS.

BY W. F. BARRETT.

Amidst all the marvels of this wonderful body of ours, there is nothing more interesting, and yet nothing of which we know so little, as those slender white strings and the clustering grey cells associated with them, which together we call the nerves. There was a time when it was considered blasphemous to investigate any vital phonomena; and, although science has done so much to clear away the thraldom of superstition, still in the present day there are not a few who regard an attempt to search out the higher phenomena of life with feelings similar to those who, in former days, feared to know how we move our limbs or digest our food. But surely no thoughtful man can think it an impious endeavour to understand the obscurer parts of the Creator's highest work. Concerning our mind, can any one think it wrong to change ignorance, "the region of disorderly mystery," into science, the "realm of orderly mystery"?—for science does not remove the mysteries which surround us; all she can do is to classify them, and thus lead us to see that true mysteriousness of nature which she is impotent to explain.

The enigma of the nerve cells has as yet been unsolved by science. But it is not so with the nerve fibres, for their function has been ascertained beyond a doubt. They are discovered to be the transmitters merely of that unknown and still greater mystery we name the nerve force, or nervous agent—a power which, acting upon the nerve cells stored up in the brain, there awakens, or is translated into consciousness. How, it is probable we can never know, for this would be a comprehension of an organ by itself; a thing as difficult to conceive of as it would be to suppose the heart alone capable of knowing how it contracts, or the stomach understanding how its functions are discharged. The superior alone can comprehend the inferior.

It is, however, a great step to know something about the nerve fibres, for they are our only means of communication with the outer world, and through them we can by gross means stir a power into action which in its turn can arouse sensation, the highest achievement of the action of force upon matter. The structure of these nerve fibres has long been known, and corresponds with the function assigned to them. They are like submarine telegraph wires, as has often, but not the less truly been said, and as such have a central core, what appears an insulating coating, and then a protecting sheath.

But if this nervous power, which we can excite with the prick of a pin, really passes from the excited part to the brain, it must take time in its transit. The velocity of electricity and of light has been measured; can the rate of propagation of this nerve force be determined? It can, and Helmholtz, the illustrious professor of physiology in Heidelberg, has made this determination with great accuracy. Though it is some time since this was accomplished, yet an admirable exposition of the whole subject has recently been given at a Friday evening meeting of the Royal Institution, by Dr. Emil du Bois Reymond, the eminent professor of physiology in the University of Berlin. A brief notice of this lecture will, we think, be acceptable to many of the readers of the INTELLECTUAL OBSERVER.

First of all, we must be convinced that there really is something travelling along the nerve. It is not necessary to suppose the passage of an entity, or "imponderable," as our fathers used to say, but as modern science would teach us, we have to conceive merely of a pulse, a transmission of motion through the nerve.

By a most ingenious arrangement, Professor du Bois Reymond illustrated by experiment the way in which he considers such a pulse to be transmitted through the nerves. A number of double magnetic needles were suspended in a long row within a glass case, so that the ends of each needle were in a line with, and close to, but not touching the needle in front. Pushing the pole of the terminal needle obliquely aside, the attraction which it exercised in its new position displaced the next adjacent needle in a contrary direction. This displaced the next, and that in its turn the next, and thus a zigzag motion ran along the row of needles to the far end, where the movement of the terminal one rang an electric bell. The propagation of nerve force is analogous to this, for, as will be seen directly, it is a slow motion, not almost instantaneously transmitted like light or electricity. To show the actual transmission of the nervous agent, the professor took a frog—and frogs are most indispensable creatures in these experiments, we believe Dr. du Bois Reymond brought over as many as 200 to illustrate his lectures at the Royal Institution—and from the hind legs of this frog dissected a muscle with its attached nerve. Stimulating the free end of the nerve by a feeble electric current, the muscle announced the reception of this stimulus by a violent contraction, rendered visible to the audience by the lifting of a coloured disc. The nerve was now tied in the middle and again stimulated; this time no contraction of the muscle occurred, the ligature had prevented the passage of the nervous agent. Thus a material change does really pass along a nerve

when it is stimulated. This change, whatever its real nature we know not, is certainly quite distinct from electricity, for that force would not have been hindered in its transit by the mere tying of the conducting nerve.

The next problem to be solved is how to determine the rate at which this change proceeds along the nerves. Only fifteen years ago, the solution of this was thought by eminent men to be impossible on account of experimental difficulties, but, as already stated, this has been done in the first instance by Helmholtz, who used a method suggested by M. Pouillet for measuring the velocity of projectiles.

When a current of very short duration is passed through a galvanometer, the deflection is proportionate to this duration, and hence the time taken by any transient phenomenon may be ascertained, provided its beginning and its end can be made to coincide exactly with the beginning and end of an electric current. This coincidence in time M. Pouillet accomplished by a most ingenious device which is in actual use in gunnery experiments. The way in which this method has been applied to the problem now under consideration, was shown by Professor du Bois Reymond, and illustrated by an experiment. Thus it was seen, by the comparative amplitude of the deflection of a galvanometer needle, the comparative duration of the passage of the nervous agent in two cases.

There is, however, besides this, another method by which the same object can be obtained much more easily. This may be termed the graphical method; and it consists in causing the muscle to be the penman, by making it write the moment of its contraction on a revolving cylinder. The contraction follows at a short but definite interval after it has received the stimulus transmitted through the nerve, and in contracting it draws a curve indicative of the beginning of the contraction, as well as of its subsequent stages. Now, if after having drawn one such curve the cylinder be turned, so as to bring it back to its starting-point, and the nerve be stimulated a second time at precisely the same place, a second curve will be drawn coinciding exactly with the first. If, however, one curve be drawn by stimulating the nerve at a point A distant from the muscle, and another by stimulating a portion B nearer the muscle, the resulting curves will not now overlap, but a displacement will be observed corresponding to the time required by the nerve force to travel from A to B. This important result was first arrived at by Helmholtz, by means of a beautiful but complicated apparatus termed the *Myographion*. In his lecture, Professor du Bois Reymond succeeded in drawing the actual curves, but instead of the rotating cylinder using a glass-plate sliding along guides and propelled by a spring. The two

curves thus drawn were rendered visible to the audience by projecting their image on the screen by means of the electric light. The difference in the commencement of the contraction in the two cases was very clearly seen; in fact, although obtained in the lecture—when, as a rule, experiments are less successful than beforehand—the curves were as distinct and almost as perfect as if they had been selected from careful laboratory experiments.

What, then, is the result of the investigations of Helmholtz on the velocity of the nerve force? It is one which, at first sight, is most astonishing; for the rate of propagation, compared with other forces, is extremely slow. The velocity of light is about 190,000 miles a second, and of electricity even more; but the velocity of the nerve force is only ninety *feet* a second, one-twentieth of the velocity of a cannon-ball, about one-thirteenth of the velocity of sound in air, and not exceeding, but about equal to, the speed of an express train. The rate at which impressions are transmitted through the nerves is more fully compared with the velocity of other forces in the following table, the measurements throughout being in metres (3·28 feet equal 1 metre) as the most convenient standard:—

	Metres in one second.
Electricity	464,000,000
Light	300,000,000
Sound through iron . . .	3,485
„ „ water . . .	1,435
„ „ air . . .	332
Cannon ball	552
Eagle's flight	35
Nerve force	28
Greyhound or racehorse . .	25
The arm in throwing a stone .	22
Gale of wind	20
Arterial wave	9
Muscular contraction . . .	1

The velocity of nervous transmission in our bodies has also been examined, by inserting fine wires in the finger and toe of a living man; through these wires the nerves could be stimulated by an electric current, and the rate of propagation measured by very delicate means. No sensible difference was found between the velocity in the nerves of a man, and in those of a frog. Therefore, as the Professor remarked, when the driver of an express train points to the tender, and wills to move his fingers, whilst performing the act the nerve force in the nerves of his arm remains

stationary in space, or nearly so, because the velocity of the train in one direction destroys that of the nervous agent in the other. In a creature so long as the whale, the rate of nervous transmission becomes very perceptible when the extremities have to be moved. The fact of a harpoon having been thrown in the tail of a good-sized whale would not be announced in the brain of this creature till a second after it had entered; and as it would take a little more than another second before the command to move its tail would reach the appropriate muscles, a boat's crew might be far away before the animal they had pierced began to lash the sea. Similar considerations would lead us to see that we could not move our fingers and legs, for example, beyond a certain rate; for were this rate to equal the time occupied by the transmission of nerve force from the part moved to the nerve centre, the successive stimuli sent along the motor nerves would link themselves into one, and the muscle would remain permanently contracted.

A very interesting fact connected with nervous transmission was mentioned by Dr. du Bois Reymond. This was the effect of temperature on the velocity of the nerve force. When the nerve was warm, the curves drawn on glass as we have described, were close together. Ice-cold water was then caused to flow over the nerve; when two new curves were drawn, they were widely separated from each other, showing that in the latter case the nervous force had travelled at a slower rate than in the former.

One other point remains to be noticed. Besides the time required for the transmission of a stimulus through the nerves, the mind takes a certain period to form a conception, and then to prompt the limbs to act accordingly. This time, measured by a similar method, has been found to be about one-tenth of a second. Some strange results have been deduced from this fact. The passage of a rifle-bullet through the brain would not occupy more than the thousandth of a second; a stroke of lightning would pass through the body in inconceivably less time; and thus a person killed by either of these means would die without consciousness having time to be produced. The placid aspect of those who have thus died, and the testimony of those who have recovered from a lightning stroke, go to prove that no pain was felt prior to the insensibility which followed the act.

The delicate and complex nature of the experiments by which all these results have been obtained has probably never been surpassed. The most refined and sensitive instruments are needed to carry them into execution, and all who looked on Professor du Bois Reymond's apparatus must have been at

once bewildered and charmed. The thanks of the English public, and especially of the medical schools, are due to the patient toil of the professor, who succeeded in transferring his fragile instruments from Berlin to London, and, after hours of laborious preparation, has given, not only the demonstration of the Friday evening we have noticed, but three other experimental lectures at the Royal Institution, and one at the College of Physicians.

HIGHLEY'S POCKET STAND MICROSCOPE.

At the last *soirée* of the Microscopical Society, Mr. Highley exhibited a new form of pocket microscope, which will meet the requirements of searchers for diatoms and other minute objects, and also those of medical men wishing for a portable instrument for the examination of morbid deposits.

The annexed cuts show this instrument, which is designated "Highley's Pocket Stand Microscope," in two positions. In the one it is folded up, and in the other the stand is unfolded,

and the mirror brought into its right position with reference to the stage.

It packs into a case seven inches long, two and a quarter wide, and two and a half deep, thus occupying no more room than a small pocket telescope. The stand being of metal, and attached to the instrument, is neater and steadier than some of the wooden stands previously introduced, and the stage, which is arranged with universal motions, will carry a small live box, or an ordinary slide. When intended for medical use, it is accompanied by a very small pocket case, containing a test-tube and holder, spirit lamp, drop bottle, and test papers, while field naturalists are supplied with another "waistcoat-pocket case," as Mr. Highley terms it, a pipette, spoon, forceps, and corked collecting tubes. They can also have a hook-handled walking-stick, into the end of which screws a net, a bottle, or a hooked knife, and they are thus supplied with all the appliances needed for pursuing their search for microscopic objects.

It is the neatest and most convenient thing of the kind we have seen, and can be made to work very well with $\frac{1}{4}$-inch objective.

ARCHÆOLOGIA.

THE BARROWS IN CUMBERLAND have been recently the scene of the zealous labours of a well-known antiquary, the Rev. W. Greenwell, of Durham. The plain to the north-east of Carlisle is covered with natural rounded hills of gravel, which, in many cases, have at their summits early sepulchral interments. Several of these have been opened by Mr. Greenwell, and presented interesting deposits. They appear to have belonged either to a period, or to a state of society, when it was customary to inter with the dead very few objects of any value, and these few present no characteristics which, in our present state of knowledge, at least, fix them to any particular date. Mr. Greenwell is labouring zealously and carefully in search of results which it may be hoped will eventually throw light on this question. In one of the barrows opened by Mr. Greenwell on this occasion, the only accompaniment of the remains of the corpse, which had undergone cremation on the spot, was a most beautiful flint knife, about four inches long, which had been struck off the cone at one blow, the side being left flat as when first struck; the other side being slightly curved, and minutely chipped over its whole surface. The bones were those of a young person. In another of these graves a cist was found, which was formed of four stones on edge, with a cover or lid of great thickness, the substance being the red sandstone of the district. This cist lay

north-east by south-west, and contained a body doubled up and laid on the left side, with the head to the north-east. Behind the head lay a small cup, of the description which some antiquaries have called drinking cups, ornamented over its whole external surface with parallel lines, made apparently by the impressions of rushes on the clay. In this case the skull was perfect, and the body presented no appearance of having been burnt, yet charcoal was found in the cist.

An accidental discovery of ROMAN COINS was made recently on the western side of CÆSAR'S CAMP, a well-known hill near Farnham in Surrey. The ground here is a continuation of Bagshot Heath, over which ran the Roman road from Winchester (*Venta*) to London. As Mr. Dowsett, one of the literary staff of the *Surrey and Hants News*, was passing over the hill on his way to Aldershot, his attention was attracted by the peculiar appearance of one or more stones almost buried in the ground, and he proceeded to remove them, when he heard a sound like the jingling of metal, and immediately afterwards perceived an old silver coin. Further examination brought to light a number of others—the number is not stated—which proved to be all Roman silver, ranging in date through a great part of the third century, A.D., with the single exception of a coin of Domitian, which belonged of course to the first century. This probably formed part of a hoard of Roman money which had been buried in this spot towards the end of the third century, or at the beginning of the fourth, thus bearing witness to the occupation of this camp by Romans at that period. It is hardly necessary to remark, that the name of Cæsar not unfrequently attached to such sites, is a comparatively modern invention, made by people who ignorantly believed that whatever was Roman must have been Cæsar's. The neighbouring town of Farnham has been supposed by antiquaries to occupy the site of a Roman town or station named *Vindonum*. The position of Cæsar's camp appears to have been occupied long after the Roman period, for in 1828, near the same spot where the Roman money was found, as stated above, a hundred coins of the Merovingian period, ranging from the fourth to the seventh century, were discovered by the late C. E. Lefroy, Esq., of Ewshot. There is another Cæsar's camp at Wimbledon, which, in some papers read before the Archæological Institute, has been pronounced to be British, on what evidence we have not been informed. It is worth a hint to those who occupy themselves with this subject, that they would do well to examine carefully the character of the entrenchments with which the supposed camps are surrounded. The Romans were the great entrenchers of antiquity, and a body of Roman troops rarely passed a night on a spot without making themselves an entrenched camp. Cæsar tells us that the Gauls were ignorant of the art of entrenchment, until they learnt it from the Roman legions under his command; and it was not until two or three years after they had seen the use the Romans made of entrenchments that they began to imitate them. As the Britons were more backward in these things than the Gauls, we

must conclude that the presence of regular entrenchments ought to be considered as evidence against the camp being British.

The SOCIETY OF ANTIQUARIES OF SCOTLAND has been much occupied of late with researches among the numerous remains of the HABITATIONS AND SEPULTURES OF THE EARLY RUDE RACES who have at a remote period formed the population of the wilder parts of North Britain. Some of these have been very interesting and instructive. Mr. Stuart, the Secretary of the Society, gave an account of the exploration of monuments of this description existing at Balnabroch and West Persie, in Strathardle, in Perthshire. At Balnabroch a great cairn forms a centre, round which are scattered numerous smaller cairns, as well as groups of what Mr. Stuart calls hut circles. The central cairn is known as the Grey Cairn. With one exception, no cists were found in the cairns, or, apparently, any traces of burial, except remains of burnt wood. The hut-circles are described as being generally from twenty-eight to thirty feet in diameter, with the entrance almost invariably from the south. At West Persie a group of hut-circles was surrounded by a wall, within which, in some cases, two circles are enclosed within another surrounding wall. In at least one instance holes were found in the floor, as though posts had been raised in them to support a roof. Traces of burning and portions of charred wood were found in most of them. The only relic found in the circles of Balnabroch was a fragment of a bronze pin. In some of those at West Persie were found portions of paving flags, many round balls of quartz, some sharping-stones, and a grinding trough formed in a large boulder. The date of this class of monuments seems to be very doubtful. We are inclined to think that their antiquity is much overrated by the Scottish antiquaries.

An ANGLO-SAXON CEMETERY, of the pagan period, and of considerable extent, near Market Harborough, in Leicestershire, has been lately the scene of extensive excavations, which have produced a considerable number of the usual objects, such as spear-heads, knives, umbos of shields, beads, etc., found in Anglo-Saxon graves. Among them was found a fine example of the double-edged Teutonic sword, thirty-four inches and a half in length, and rather more than two inches broad. The graves were laid in rows, disposed east and west, with the feet towards the east.

One of the most curious objects recently discovered in the excavations in France, is what we may venture to call a ROMAN GRIDIRON. It is engraved and described in a recent work by M. Maximilien de Ring, who has made extensive researches in the early cemeteries and burial-places in Alsace. This implement is extremely well made of iron coated with bronze, with a raised open guard on one side for the meat, and a groove to catch the melted fat. Along with this implement, in the same grave, were found a long iron knife and a bronze spoon or ladle with a long iron handle. M. de Ring supposes that they had been used in preparing the feast at the interment.

T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

The most important subject that has occupied the attention of the Royal Society is the remarkable spectrum of the new star, examined by Mr. Huggins, and on which a paper by him was read on the 17th. This subject is treated in a separate article in our present number.

GEOLOGICAL SOCIETY.—*April* 25.

Mr. Tyler read a paper on THE INTERVALS OF TIME BETWEEN THE FORMATION OF THE UPPER AND LOWER VALLEY GRAVELS OF ENGLAND AND FRANCE, with notes on the character of the holes bored by mollusca. His object was to show that the two gravels were not separated by the long time interval supposed by Mr. Prestwich and other geologists, and that they may not have existed upon the earth as long as they conceived.

On the 9th of May a paper by Mr. Seeley was read on THE GRAVELS AND DRIFTS OF FENLAND, the flat country west of the chalk hills of Norfolk. Three kinds of drift were described as occurring, and Mr. Seeley considered that the brown clay of the eastern counties corresponded with the brown boulder clay which is the oldest of the Fenland drift deposits.

Professor Harkness and Mr. Nicholson contributed a paper on THE GEOLOGY OF THE LAKE COUNTRY, with a note on the trilobites by Mr. Salter. They contributed several additions to Skiddaw slate fossils, and stated that the fossiliferous rocks discovered by them among the "ash-beds" of the Lake Country were on the same horizon as those associated with the purely igneous rocks of the eastern parts of Cumberland and Westmoreland, which underlie the Coniston limestone, and are of Caradoc age.

MICROSCOPICAL SOCIETY.—*May* 7.

Mr. Wenham read a paper on his new arrangement for binocular vision with high powers, on which an interesting discussion took place. No true stereoscopic effect was claimed for this invention (fully described in our last number), but it was considered that it would enable prolonged investigations to be made with less fatigue. Mr. Wenham exhibited some objects very beautifully displayed by his new method with a twelfth.

QUEKETT MICROSCOPICAL CLUB.—*April* 27.

Mr. Highley read a paper on THE APPLICATION OF PHOTOGRAPHY AND THE MAGIC LANTERN TO MICROSCOPICAL INVESTIGATION. Mr. Highley has devised excellent arrangements for these purposes, which are highly esteemed by those who have seen them.

PROGRESS OF INVENTION.

SIMPLE MODE OF OBTAINING SODA FROM COMMON SALT.—The ordinary process used for this purpose is complicated and expensive; one far more simple and economic has lately been discovered. It consists in pumping the carbonic acid obtained by transmission of atmospheric air through ignited fuel into a mixture which contains one equivalent of common salt, one equivalent of carbonate of magnesia, and a small quantity of water, and has been placed in a vessel capable of resisting the required pressure. The changes which occur are very easily understood. The carbonate of magnesia becomes bicarbonate, and dissolves in the water. The bicarbonate of magnesia decomposes the chloride of sodinm, chloride of magnesium which remains in the solution, and bicarbonate of soda which precipitates, being the results. A moderate heat will drive off the second atom of carbonic acid from the bicarbonate of soda, changing it into carbonate. The whole process lasts but about one quarter of an hour, and the magnesia employed can be used over and over again, since it may be recovered by evaporating the solution containing it as chloride to dryness, and raising the residue to a temperature below redness. The importance of a simple means of obtaining soda from common salt may be judged from the fact that seven hundred thousand tons of soda, worth about five millions sterling, are consumed annually in England.

DAGUERREOTYPES ON COPPER.—The process of Daguerre has certain good qualities which have prevented it from having been ever entirely set aside. The cost of plated copper, hitherto indispensable, has, however, always been a serious objection. This difficulty has been removed; and very excellent pictures may now be obtained, by a very simple method, on pure copper. It is true that it necessitates a much longer exposure than is desirable, or even possible, in many cases; but it is more rapid than when plated copper is employed, and it answers well for a great number of purposes. A smooth and perfectly clean copper plate is dipped for about thirty seconds in a bath formed with 125 grains sulphate of copper, 75 grains common salt, and 2 ounces of water which has been acidulated with a few drops of any acid; and after having been withdrawn, is washed, and dried with a soft cloth. It is now ready for exposure, and is to be left for a few minutes—the number depending on the state of the weather—under a glass negative. The picture thus obtained is fixed by immersion for a few seconds in a solution of hyposulphite of soda, containing a little chloride of silver. It must be taken out of the hyposulphite as soon as the portions which were reddish whiten, and the shadows assume a violet tint, which passes into black; and, having been washed, it is to be dried over a spirit lamp. As the blacks consist of a fine powder, the picture will be easily destroyed unless it is varnished. The changes which take place during the process are not known with certainty. It is supposed, however, that the sensitive surface consists of protochloride of copper, and that the portion of this which has not been acted on by the light is dissolved by the

hypochloride, silver being thrown down on the copper surface thus laid bare.

DAGUERREOTYPES ON SILVERED GLASS.—Besides pure copper, of which we have already spoken, as a substitute for plated copper in the daguerreotype process, another substance, silvered glass, has been proposed, and it seems to possess peculiar advantages. Each element of the old daguerreotype plate has thus in its turn been discarded—the silver by the use of pure copper, the copper by the use of plated glass, which, probably from the absence of copper, is very sensitive. A film of silver, so tenacious as to be capable of being burnished, is obtained on the glass by means of Rochelle salt in a solution of ammonia and nitrate of silver, and the quantity of metal contained in it is so small that one half-penny worth of silver will cover a surface of nearly 200 square inches. An alcoholic solution of cyanide of potassium must be used for fixing, instead of hyposulphite of soda, which might break up the silver surface; and the washing must be effected with alcohol instead of water. The pictures obtained in this way have a rosy tint which is very pleasing. The mercury used in developing is likely to pass through the silver, so as to produce a picture on both sides of it.

ANOTHER SUBSTITUTE FOR GUNPOWDER.—Of the substances which have been considered likely to supersede gunpowder, hitherto, guncotton and nitro-glycerine have attracted the most attention. But of these the former, notwithstanding its many advantages, is liable to such serious objection, that the Austrian Government, notwithstanding the great preparations which had been made for its introduction into the appliances of war, has issued the most stringent prohibitions against the use of it. The terrible explosions which have lately been caused by nitro-glycerine will go very far towards preventing its employment even in mining, for which it would appear specially adapted. Another substitute for gunpowder, in the form of *gun paper*, has been recently proposed, and the experiments made with it have afforded very favourable results. It is formed by impregnating paper with a composition which consists of nine per cent. chlorate of potash, four and a half per cent. nitrate of potash, three and a quarter ferrocyanide of potassium, three and a quarter powdered charcoal, five hundredths per cent. starch, six hundredths chromate of potash, and nearly eighty per cent. water, and has been boiled for about an hour. This mixture is perfectly safe; and the paper impregnated with it, even in the dried state, cannot be exploded by percussion, nor by a heat lower than that of ignition. While wet, the prepared paper is made into rolls of any required size, which, having been dried at a temperature of 212° Fahr., are cut into cartridges, that may be protected from damp by a coating of xyloidin dissolved in acetic acid.

ORIGIN OF THE CARBURETS WHICH CONSTITUTE SOME OF THE PRINCIPAL SOURCES OF OUR FUEL AND LIGHTING MATERIALS.—Now that so serious, and it may be added general alarm, has been caused by the fear that our coal supply must necessarily be exhausted within a limited period, it is consolatory to find that, very probably, our stores of substances which, at least, may be made excellent substitutes for it are being constantly replenished. Should car-

bonaceous matters remain indispensable for the purposes for which we at present use them, a continuous provision of them might be expected, if we take into account the provisions which have been made for the wants of men. The researches and experiments of M. Berthelot lead to the supposition, if not to the certainty, that those mineral fuels which are not, like ordinary coal, derived from transformed organic matter, are being produced continually by mineral reactions such as geology would lead us to expect. Thus there is reason to believe that free alkaline metals at a high temperature, are contained in the interior of the earth. Carbonic acid penetrating to these through the solid crust would form acetylurets; which coming into contact with watery vapour, in presence of hydrogen and certain other bodies, would form either bitumens and tars, or compounds still richer in hydrogen.

If these conclusions be well founded, there is little danger of any failure in our supply of asphalte and petroleum; and experiments have already shown that these would constitute excellent substitutes as fuel for mineral coal.

MISCELLANEOUS.—*Action of Certain Metals on a Strong Solution of Chlorine.*—If platinum black is introduced into a strong solution of chlorine in water, the latter will be decomposed, hydrochloric acid being formed and oxygen evolved. Spongy platinum is still more energetic in producing this effect than platinum black, and spongy ruthenium still more so than spongy platinum. The ruthenium preserves its power, though in contact with the chlorine water, for a long period, and it acts as well in the dark as in the light. Rhodium is as effective as ruthenium, but pulverulent iridium is much less so. Schönbein supposes that the platinum, etc., decompose the solution of chlorine, on account of chlorine being a compound of *murium* acid and oxygen, the latter being evolved because of its becoming incapable of remaining in combination, on account of ceasing to be ozone. It is certain that these metals have the same effect on ozonized oxygen as a temperature of 302° Fahr., rendering it incapable of acting on iodized starch paper.——*Use of Paraffin for Preserving Animal Substances.*—Recent experiments have shown that, if meat is first plunged, for a length of time dependent on the size of the mass, into a bath of paraffin, which has been raised to the temperature of 300° Fahr., and then twice or thrice into a second bath of the same substance which is at a lower temperature, it will be preserved from any change for an indefinite period. All the air and water which would have induced putrefaction have been driven off.——*New Application of Refraction.*—Refraction is now applied to the determination of the amount of a given substance in a solution. For this purpose empirical tables of the deviations caused by different quantities of a given salt in a solution having been formed, the solution to be tested is put in the upper portion of a hollow prism, divided in the centre, and having its lower part filled with distilled water. If a scale, lighted by the flame of salted alcohol, is then observed through the prism, the difference of the deviations produced by the two liquids will be seen; and, from this, the quantity of salt in the given solution may be found by the table.

NOTES AND MEMORANDA.

WORMS AND STAPHYLINIDÆ.—Mr. N. S. Heineken, of Sidmouth, writes to tell us that Mr. Bray, photographer of that place, saw, on the 8th of April, a large worm crawl out of the ground, and suffering attack from an insect "of rather a yellow colour, and about the size and not unlike an earwig." Mr. Stainton, after seeing a sketch, kindly informs us that the creature must have "been one of the staphylinidæ, either in the larval or perfect state, probably the former." The worm only succeeded in escaping, at the expense of losing two segments, on which the insect fed. Mr. Stainton saw a similar battle in May, in which a staphylinus cut off about two inches from a worm, which still continued to struggle with its captor. For a similar account we refer our readers to Dallas *Elements of Entomology*, p. 96. Swammerdam, cited by Westwood (vol. i. p. 166), says that the staphylinus "can very quickly kill earthworms with its teeth, and afterwards suck them."

AIRY ON TIDE FRICTION.—*Monthly Notices*, vol. xxvi., No. 6, contains an important paper by the Astronomer Royal, on the supposed effect of friction in the tides in "influencing the apparent acceleration of the moon's mean motion in longitude." Mr. Airy refers to M. Delaunay's opinion that the apparent acceleration of the moon is due to a real retardation of the earth, arising from friction in the tidal movement of the waters; and after an elaborate investigation, only intelligible to good mathematicians, he says, "I am very happy to give my entire assent to the general views of M. Delaunay on the existence of one real cause for the retardation of the earth's motion."

THE COMPANION TO SIRIUS was seen by Mr. G. Knott, of Cuckfield, on the 24th of January, with his 7½-inch Alson Clarke refractor. He says, "I was surprised to find the small companion, notwithstanding bright moonlight, a tolerably conspicuous object. Its colour was a fine pale blue (about blue^3 of the late Admiral Smyth's chromatic scale), and it has a sufficiently strong illumination to allow of my measuring it in position and distance with a wire micrometer mag., power 375. P. 77° 21; obs. 5 W. 22; D. 10″·433; obs. 4 W. 10; epoch 1866·064 (*Monthly Notices*). These measures agree approximately with a series made at Washington. See *Ast. Nachr.*, No. 1584.

THE COMPANION OF ANTARES.—Mr. Cottam has a letter in *Monthly Notices* referring to Mr. Freeman's account of his seeing the above object at Mentone, and stating that at Bushey Heath, near Watford, on two evenings last summer, he saw it without difficulty with a 4½-inch object-glass. Many of our readers, with moderate-sized instruments, may have a similar chance this summer.

FLUORESCENCE.—Dr. Bence Jones and Dr. Duprée describe in *Proceedings of the Royal Society* an extractible fluorescent substance in animals and man, and they give the following remarkable experiments on the delicacy of the fluorescent test of sulphate of quinine:—"One grain of sulphate of quinine was dissolved in five ounces of acidified water, and this was again and again diluted until one grain of quinine salt was present in 1,800,000 parts of water. This, when examined in a quartz cell by the induction spark, showed blue fluorescence distinctly in twenty grains of solution." In another experiment one grain of the salt was dissolved in one litre of water, and diluted to 512 litres. "This was equal to one part in 7,200,000 parts of water. As the fluorescence could be seen in twenty grains of this solution, $\frac{1}{360000}$ of a grain of sulphate of quinine gives fluorescence." They add, "If one grain of disulphate of quinine, dissolved in a thousand litres, or one part of quinine to 15,440,000 of water, it is still perceptible in one ounce of the solution."

SEELEY ON PTERODACTYLES.—Mr. Seeley adduces reasons for supposing that the "Pterodactyle was quadruped, and when not flying, carried its wings folded up in front of the fore limbs." From a consideration of various points of structure, he concludes that "the Pterodactyle's place in nature appears to be side by side with the birds, between the reptiles and the mammals." *Ann. Nat. Hist.*

VOCAL POWERS OF FISH.—In a former number we gave an account of M. Dufosse's researches into the vocal organs possessed by certain fishes. He has recently brought the subject again before the French Academy. He observes that

nature has not preserved amongst fishes that unity of mechanism for sonorous purposes which exists in the three first classes of vertebrates. The least favoured species have an apparatus in which muscular vibration is the principal motive power. Others can make blowing noises (*bruits de souffle*) like certain reptiles; while some can only make stridulous noises by a mechanism resembling that of insects. The *Maigres* (Sciænoid fishes) have the most perfect vocal organs, with tubular ramifications of the air-bladder, associated with muscular bands.

Boring Polyzoa.—M. P. Fischer says in *Comptes Rendus*, "Among the brylyozoa (polyzoa) the existence of boring cells is a fact almost new. Some Lepralia and Cellipora were known to act slightly upon the surface of the shells on which they fixed themselves; but before the discovery of Alcide D'Orbigny no one saw such objects lodged in the interior even of shells." M. D'Orbigny instituted the genus *Terebripora* for two boring polyzoa which he discovered in South America. M. Fischer says, besides the Terebripora, he has discovered on the coasts of the Gironde and Charente Inferieure a polyzoon of the same family which he calls *Spathipora*. It has alternate cells, borne on alternate axes, and makes elegant patterns in the shells it attacks, like the arborescent forms of Sertularia. He has not been able to ascertain in what way this boring is effected.

Composition of Tallow.—Mr. Chevreul states, in *Comptes Rendus*, that mutton tallow contains twenty-nine separate substances, amongst which are a number of acids. The majority are united with potash, some with ammonia, lime, magnesia, oxides of iron, manganese, and copper. He enumerates thirteen of these acids, and states that he has discovered another, which he proposes to term *élique*, from ἔλαιον, oil, a name which comes awkwardly near that of another acid which is already known as elaic. This élique acid he describes as colourless, rather heavier than water, liquid at ordinary temperatures, and almost insoluble in water. With baryta it forms a soluble salt, a dilute solution of which becomes turbid, and deposits a substance like a varnish on the walls of the containing vessel.

A Variable Diamond.—M. M. Halphen has presented to the French Academy a remarkable diamond, of which the following account is given in *Comptes Rendus*:—"In its normal state this stone is white, slightly tinged with brown. When subjected to the action of fire, it assumes a clear rose tint, which it keeps from eight to ten days, and which it gradually loses to revert to its original appearance. This modification may be effected at will, and it has actually been caused five times. It was first noticed by an observer who accidentally exposed it to prolonged heat. Similar experiments made with other diamonds have not yielded the same result. This question of colouration will be readily appreciated by the Academy when it is informed that the stone in its normal state is worth about 60,000 francs, while if the rose tint were permanent, it would be worth from 150,000 to 200,000 francs."

Guillemin's "The Heavens" (Le Ciel).—We have waited for the *third* edition of this excellent work to institute a fair comparison between the original and Mr. Lockyer's well-executed translation, which is seriously damaged in value by the inferiority of the plates. In the French edition before us they are singularly beautiful, and executed very much in the style which our readers are acquainted with from the artistic drawings of the Hon. Mrs. Ward in this magazine and in her *Telescope Teachings*. We are obliged to postpone a lengthened comparison of the *third* edition of Guillemin and the translation of the *second*, published by Mr. Bentley. The *third* French edition enjoys the especial commendation of Le Verrier; and although its plates are finer than Mr. Bentley's, and the type is larger and handsomer, the price *is much less*. Mr. Bentley's, with the inferior plates, is issued to the public for £1 11s. 6d., while the *third* French edition may be had for £1.

EGG FUNGI.

(Plate I.)

Fig. 1.—Aserŏe rubra, Labill.
Fig. 2.—Simblum flavescens, Kurtz.
Fig. 3.—Cynophallus bambusinus, Zolling.
Fig. 4.—Dictyophora phalloidea, Idv.
Fig. 5.—Clathrus triscapus, Fries.